Passaic River Study Area Data Presentation

September 26, 2002

Newark, New Jersey

401914

TIERRA SOLUTIONS, INC.

Agenda

- 8:30 a.m.
  Breakfast at NJTPA
  (receipts available)
- 9:00 a.m.
  Introduction
  (G. Mancini)
  - Participant introductions
  - Safety/logistics/housekeeping
  - Orientation and presentation format
- 9:15 a.m.
  PCB Sources Identification
  (including a brief dioxin sources identification preview)
  (D. Farley)
- 10:15 a.m.
  Habitat Quantification
  (D. Ludwig)
  - Summary and interpretation
- 10:45 a.m. BREAK
- 11:00 a.m.
  Benthic Community Analysis
  (T. Iannuzzi)
  - Summary and interpretation
- 11:30 a.m.
  Fish Community Analysis
  (D. Ludwig)
  - Summary and interpretation
- 12:00 a.m. LUNCH
- 1:30 p.m.
  Preliminary Sediment Quality Triad (SQT) & Toxicity Identification Evaluation (TIE) Analysis
  (T. Iannuzzi)
  - Summaries and interpretation
- 2:30 p.m.
  Topical Discussions and Q&A
  (All)

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Agenda (cont'd)

- 3:00 p.m.
  Action Items/Next Meeting
  (G. Mancini)
  - Possible dates
  - Dioxin sources identification analyses
  - Other presentations?

- 5:00 p.m. ADJOURN

Meeting Overview

- Welcome and participant introductions
- Safety, logistics and housekeeping
- Handouts and supplemental materials
- Agenda and format

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Meeting Objectives

- Summarize and interpret data
- Characterize study area
- Present and discuss source analyses
- Engage Q&A and discussion

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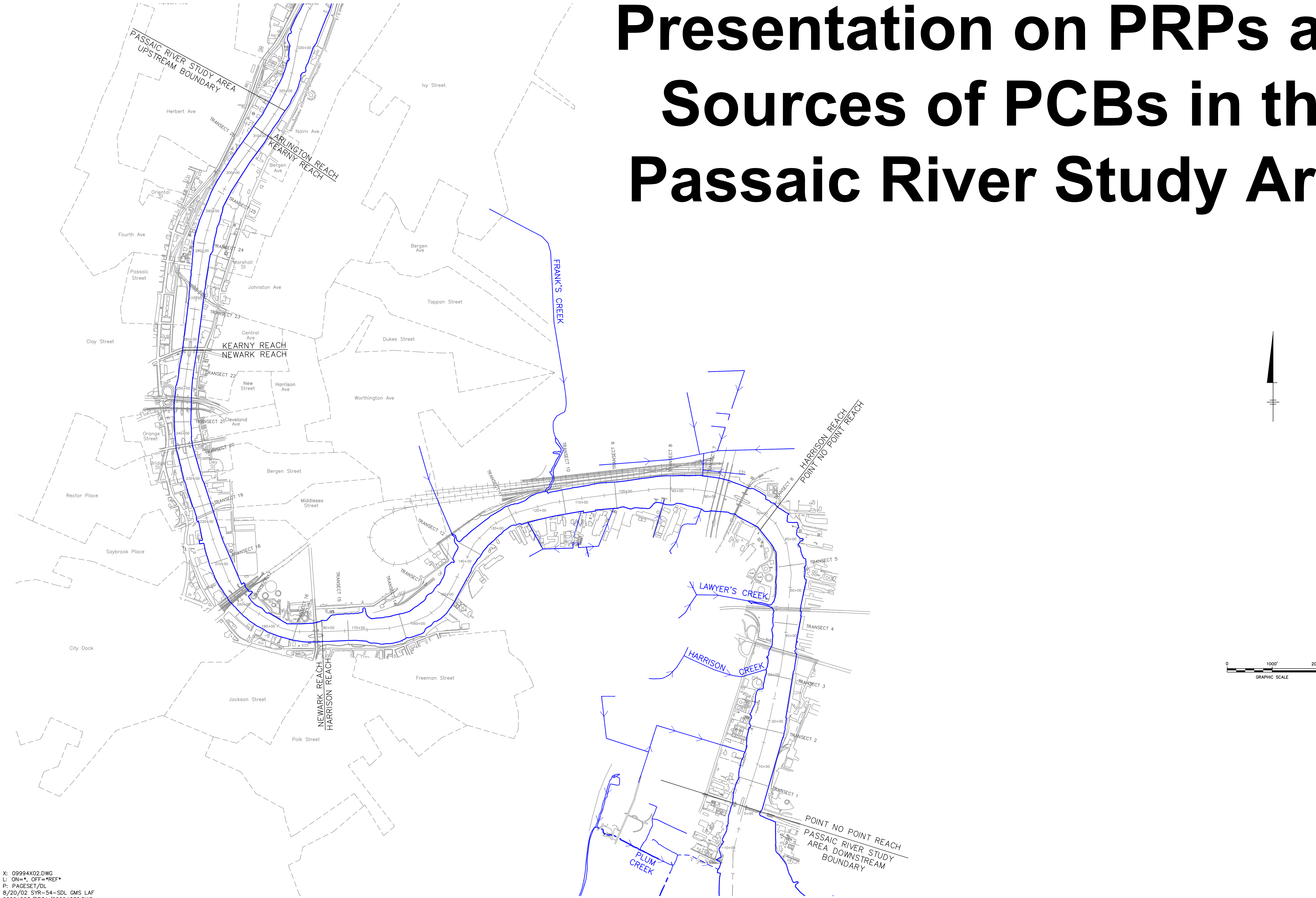
PRPs and Sources of PCBs in the Passaic River Study Area

Presentation on PRPs and Sources of PCBs in the Passaic River Study Area



Facts Regarding PCBs in the PRSA

- PRSA sediments contain elevated concentrations of PCBs.
- Numerous potential sources of PCBs to PRSA sediments have been identified – these “PRPs” include historical users and handlers of PCBs and PCB-contaminated products.
- PCB-contaminated soil and/or groundwater exist(s) at many of these PRPs’ upland locations.
- Many of these PRP locations have historical and/or present day discharge pathways to the PRSA.
- Additional investigation will reveal more PRPs – both within the PRSA as well as the PRRI area.

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Why Focus on PCBs?

- PCB contamination of sediments important from a Risk Assessment standpoint.
- Fishing Ban in-place since mid-1980s in Newark Bay complex, including the PRSA.
- Many sources are present.

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Sources of PCBs to the Environment

- As manufacturing products, such as Aroclors, for uses including:
  - Electrical capacitors and transformers
  - Vacuum pumps
  - Hydraulic fluids
  - Heat transfer systems
  - Adhesives
  - Paints and inks
  - Plasticizers
  - Cutting oils and de-dusting agents
- As contaminants in recycled oil
- Inadvertent generation, from processes such as:
  - Pigment manufacture
  - Dye manufacture

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PCB Investigation Context

- Focus to date only on PRSA – to assist USEPA in identifying PRPs for PCB contamination.
- Presented to USEPA on 18 December 2001.
- Future focus on the PRRI area will yield additional PRPs.
- Evidence more readily available regarding PCB sources than dioxin sources – most sites are typically sampled for PCBs, but not dioxins.

PCB Investigation Overview: PRP Evidence

- Gathered evidence on approximately 75 PRPs.
- PRPs identified are: users/handlers of PCBs, operators of sites with PCB contamination, or entities using processes known to inadvertently generate PCBs.
- Identified from publicly available records, including:
  - USEPA enforcement and compliance records
  - NJDEP site remediation records and files
  - local city records
  - product sales records
  - PRP responses to CERCLA 104(e) requests.

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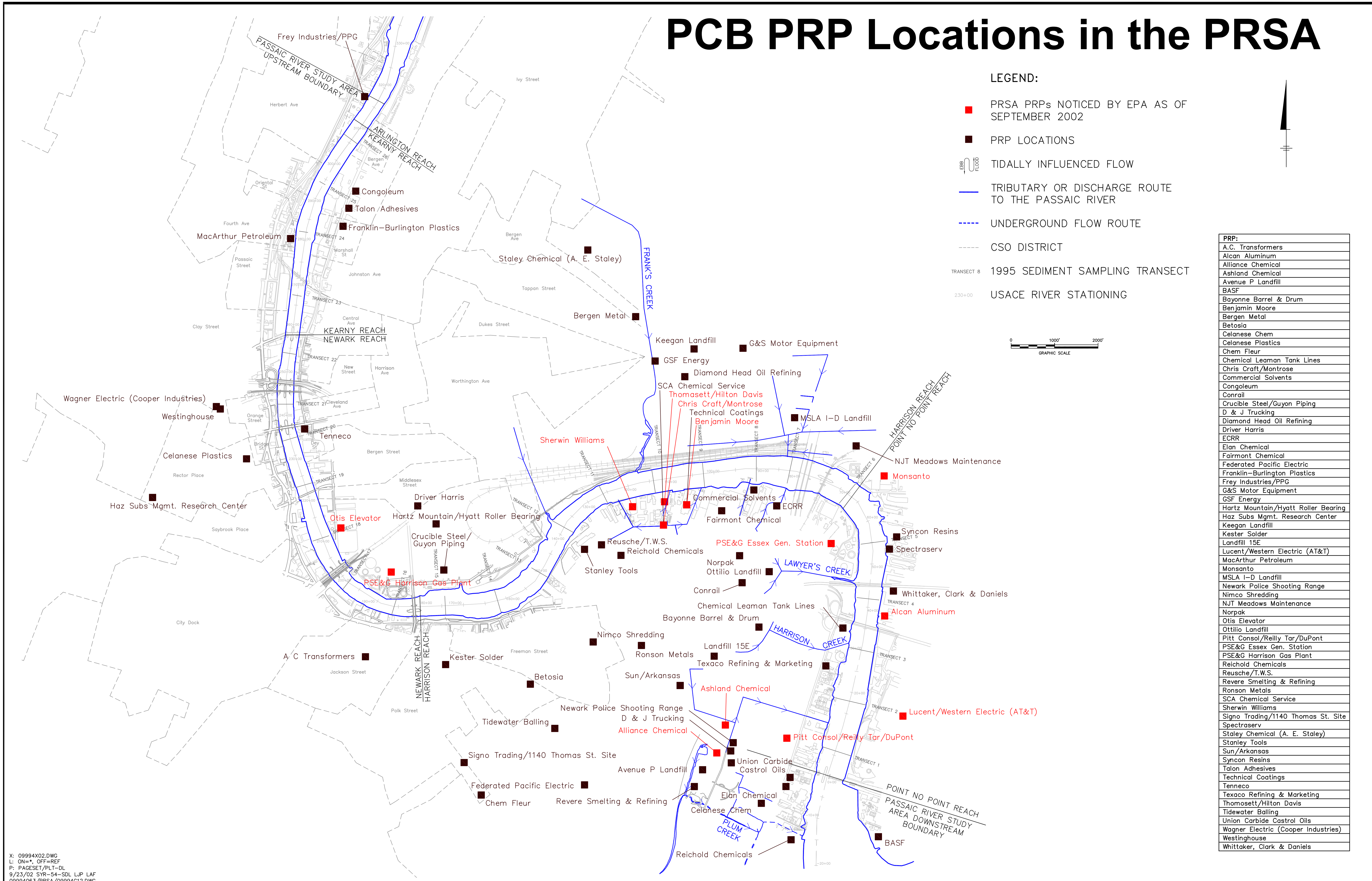
PCB PRP Locations in the PRSA



PRP:
A.C. Transformers
Alcan Aluminum
Alliance Chemical
Ashland Chemical
Avenue P Landfill
BASF
Bayonne Barrel & Drum
Benjamin Moore
Bergen Metal
Betosia
Celanese Chem
Celanese Plastics
Chem Fleur
Chemical Leaman Tank Lines
Chris Craft/Montrose
Commercial Solvents
Congoleum
Conrail
Crucible Steel/Guyon Piping
D & J Trucking
Diamond Head Oil Refining
Driver Harris
ECRR
Elan Chemical
Fairmont Chemical
Federated Pacific Electric
Franklin–Burlington Plastics
Frey Industries/PPG
G&S Motor Equipment
GSF Energy
Hartz Mountain/Hyatt Roller Bearing
Haz Subs Mgmt. Research Center
Keegan Landfill
Kester Solder
Landfill 15E
Lucent/Western Electric (AT&T)
MacArthur Petroleum
Monsanto
MSLA I–D Landfill
Newark Police Shooting Range
Nimco Shredding
NJT Meadows Maintenance
Norpak
Otis Elevator
Ottilio Landfill
Pitt Consol/Reilly Tar/DuPont
PSE&G Essex Gen. Station
PSE&G Harrison Gas Plant
Reichold Chemicals
Reusche/T.W.S.
Revere Smelting & Refining
Ronson Metals
SCA Chemical Service
Sherwin Williams
Signo Trading/1140 Thomas St. Site
Spectraserv
Staley Chemical (A. E. Staley)
Stanley Tools
Sun/Arkansas
Syncon Resins
Talon Adhesives
Technical Coatings
Tenneco
Texaco Refining & Marketing
Thomasett/Hilton Davis
Tidewater Balling
Union Carbide Castrol Oils
Wagner Electric (Cooper Industries)
Westinghouse
Whittaker, Clark & Daniels

PCB Investigation Overview: PRP Evidence

- Evaluated evidence for each PRP location to identify historical or present day discharge pathways to the PRSA.
- Compared evidence for each PRP location to the PRSA sediment chemistry near the site's discharge pathway(s).

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PCB Investigation Overview: Sedimentary Chemistry

- PRSA sediment chemistry was reviewed to identify areas of peak concentrations of PCBs.
- Both Aroclors and dioxin-like congeners were utilized:
  - Aroclors historically utilized in sampling of upland sources.
  - Dioxin-like congeners are utilized to assess risk in sediments.

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PCB Investigation Overview: Sediment Chemistry

- PCB Aroclors considered are:

1221	1248	1260
1242	1254	

- Dioxin-like PCB congeners considered are:

BZ77	BZ118	BZ157	BZ189
BZ105	BZ126	BZ167	
BZ114	BZ156	BZ169	

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PCB Investigation Overview: Sediment Chemistry

- Grouped sediment data for each Aroclor and congener by:
  - Highest individual measurement
  - Top 5% of detected concentrations
  - Top 25% of detected concentrations
- Each sampling location is a “core” – typically representing 3 to 6 individual sampling depth ranges.
- The sample locations were evaluated as to their proximity to PCB sources, and the sample depth ranges were evaluated to help approximate the period of PCB discharge.

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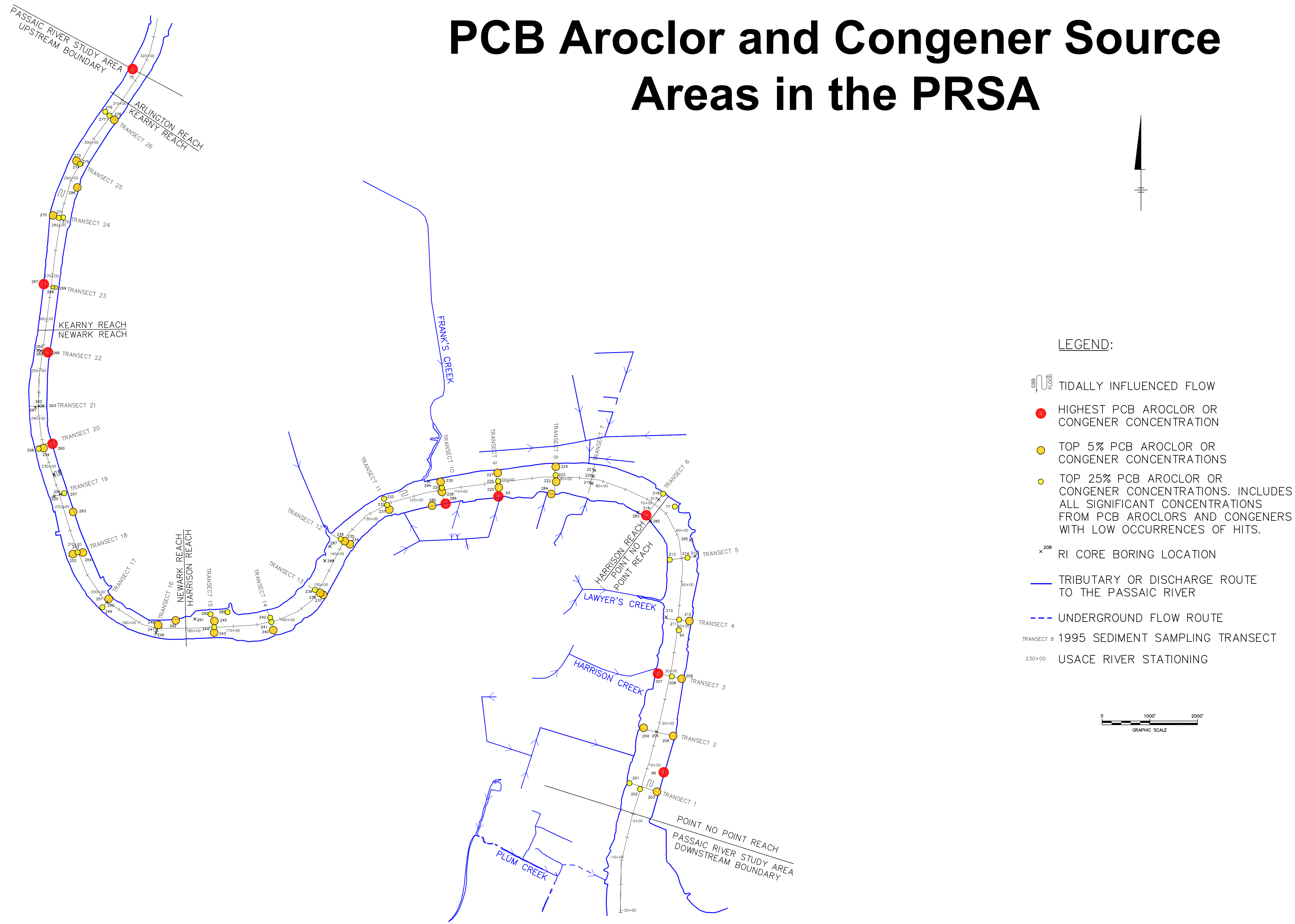
PCB Aroclor and Congener Source Areas in the PRSA



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Sedimentary Chemistry Observations

- There is ubiquitous PCB contamination of PRSA sediments.
- Despite the wide-spread nature of this contamination, PRPs can be identified.
- Further investigation will yield additional PRPs.

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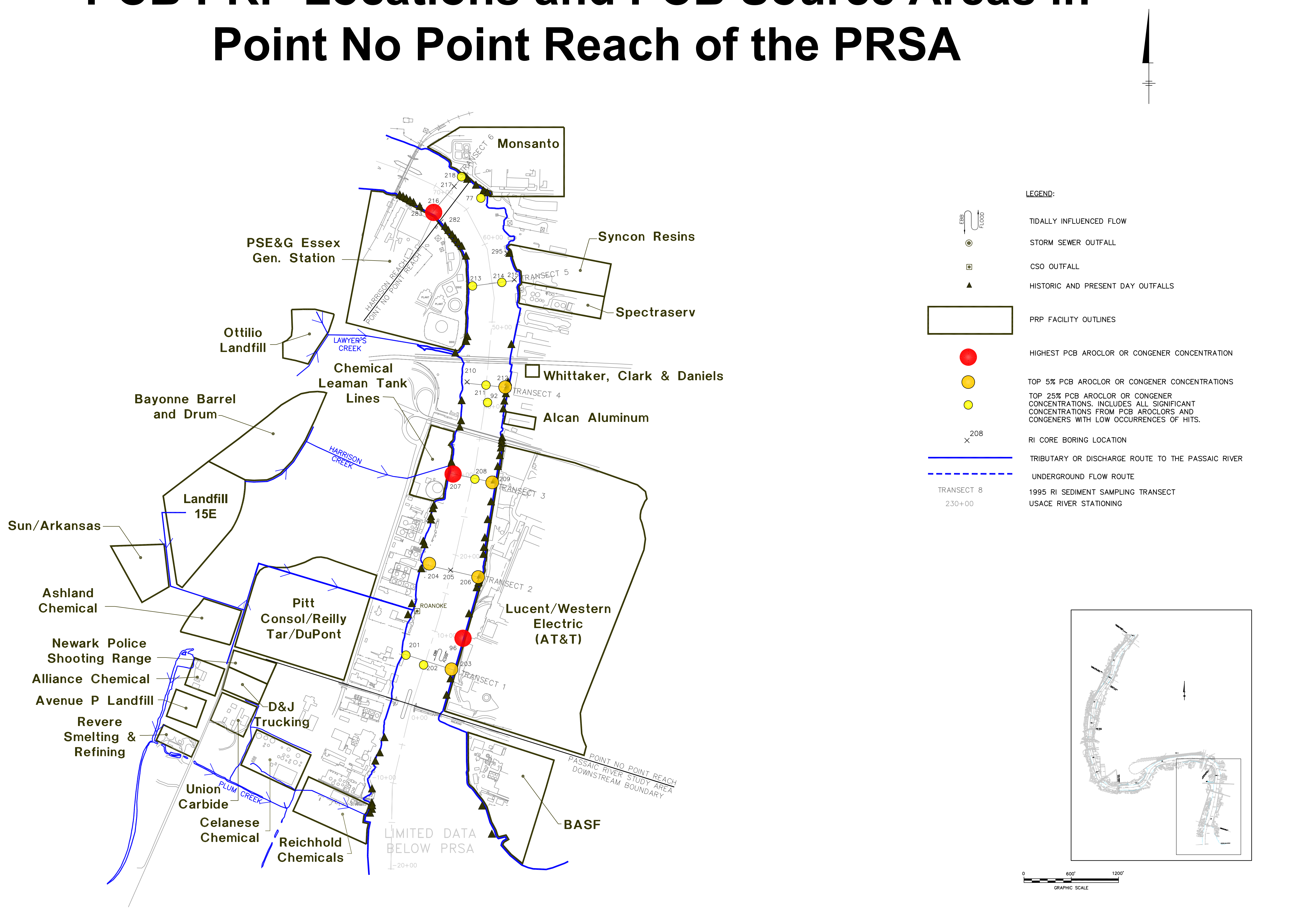
Reach-by-Reach Presentation

PCB PRP Locations and PCB Source Areas in Point No Point Reach of the PRSA



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PCB PRP Locations and PCB Source Areas Along Point No Point Reach Eastern Riverbank

LEGEND:

EBB FLOOD — TIDALLY INFLUENCED FLOW

STORM SEWER OUTFALL

CSO OUTFALL

HISTORIC AND PRESENT DAY OUTFALLS

PRP FACILITY OUTLINES

HIGHEST PCB AROCLOR OR CONGENER CONCENTRATION

TOP 5% PCB AROCLOR OR CONGENER CONCENTRATIONS

TOP 25% PCB AROCLOR OR CONGENER CONCENTRATIONS. INCLUDES ALL SIGNIFICANT CONCENTRATIONS FROM PCB AROCLORS AND CONGENERS WITH LOW OCCURRENCES OF HITS.

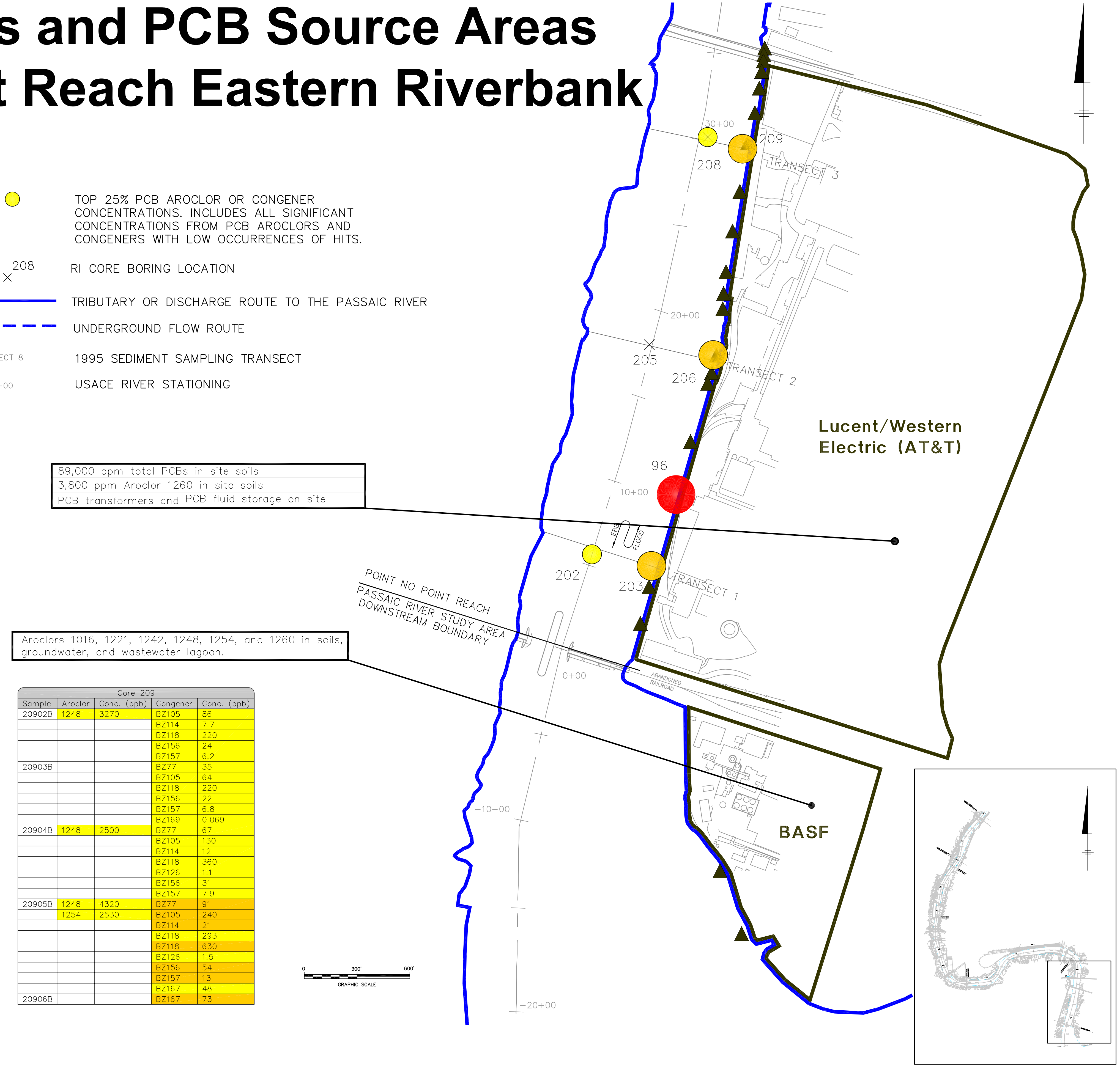
208 — RI CORE BORING LOCATION

TRIBUTARY OR DISCHARGE ROUTE TO THE PASSAIC RIVER

UNDERGROUND FLOW ROUTE

TRANSECT 8 — 1995 SEDIMENT SAMPLING TRANSECT

230+00 — USACE RIVER STATIONING



Core 96				
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
96A017	1248	3280	BZ77	33
			BZ105	65
			BZ126	1.3
96A047	1260	765	BZ77	42
			BZ105	72
			BZ118	260
			BZ126	1.2
			BZ169	0.13
96A077	1260	8730	BZ105	75

Core 202				
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20205E			BZ105	60
			BZ118	170
			BZ157	5
20206E			BZ77	30
			BZ105	67
			BZ118	220
			BZ156	22
			BZ157	6.4

Core 203				
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20308A	1248	2850	BZ77	83
			BZ105	160
			BZ114	15
			BZ118	430
			BZ126	1.3
			BZ156	47
			BZ157	13
			BZ167	34
			BZ169	0.059
20310A	1248	3250	BZ77	43
	1254	1670	BZ105	180
			BZ114	11
			BZ118	450
			BZ118	216
			BZ126	1.1
			BZ156	42
			BZ157	11
			BZ167	28
			BZ169	0.058

Core 206				
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20602A			BZ105	75
			BZ118	190
			BZ156	21
			BZ157	4.5
			BZ189	1.8
20603A	1248	2250	BZ77	29
	1260	1080	BZ105	78
			BZ114	7.1
			BZ118	210
			BZ126	0.96
			BZ156	25
			BZ157	5.7
			BZ167	28
			BZ189	2.6
20604A	1248	4490	BZ77	73
	1254	2370	BZ105	130
			BZ114	14
			BZ118	330
			BZ118	256
			BZ126	1.2
			BZ156	35
			BZ157	6.4
			BZ167	40
			BZ189	2.9
20605A	1248	4720	BZ77	98
	1254	2970	BZ105	190
			BZ114	19
			BZ118	440
			BZ118	361
			BZ126	1.5
			BZ156	49
			BZ157	8.9
			BZ167	53
			BZ189	3.7
20606A			BZ167	29

Core 208				
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20802A	1248	2570	BZ77	62
			BZ105	98
			BZ114	8.8
			BZ118	250
			BZ156	23
			BZ157	5.7
			BZ169	0.063

Core 209				
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20902B	1248	3270	BZ105	86
			BZ114	7.7
			BZ118	220
			BZ156	24
			BZ157	6.2
20903B			BZ77	35
			BZ105	64
			BZ118	220
			BZ156	22
			BZ157	6.8
			BZ169	0.069
20904B	1248	2500	BZ77	67
			BZ105	130
			BZ114	12
			BZ118	360
			BZ126	1.1
			BZ156	31
			BZ157	7.9
20905B	1248	4320	BZ77	91
	1254	2530	BZ105	240
			BZ114	21
			BZ118	293
			BZ118	630
			BZ126	1.5
			BZ156	54
			BZ157	13
			BZ167	48
20906B			BZ167	73

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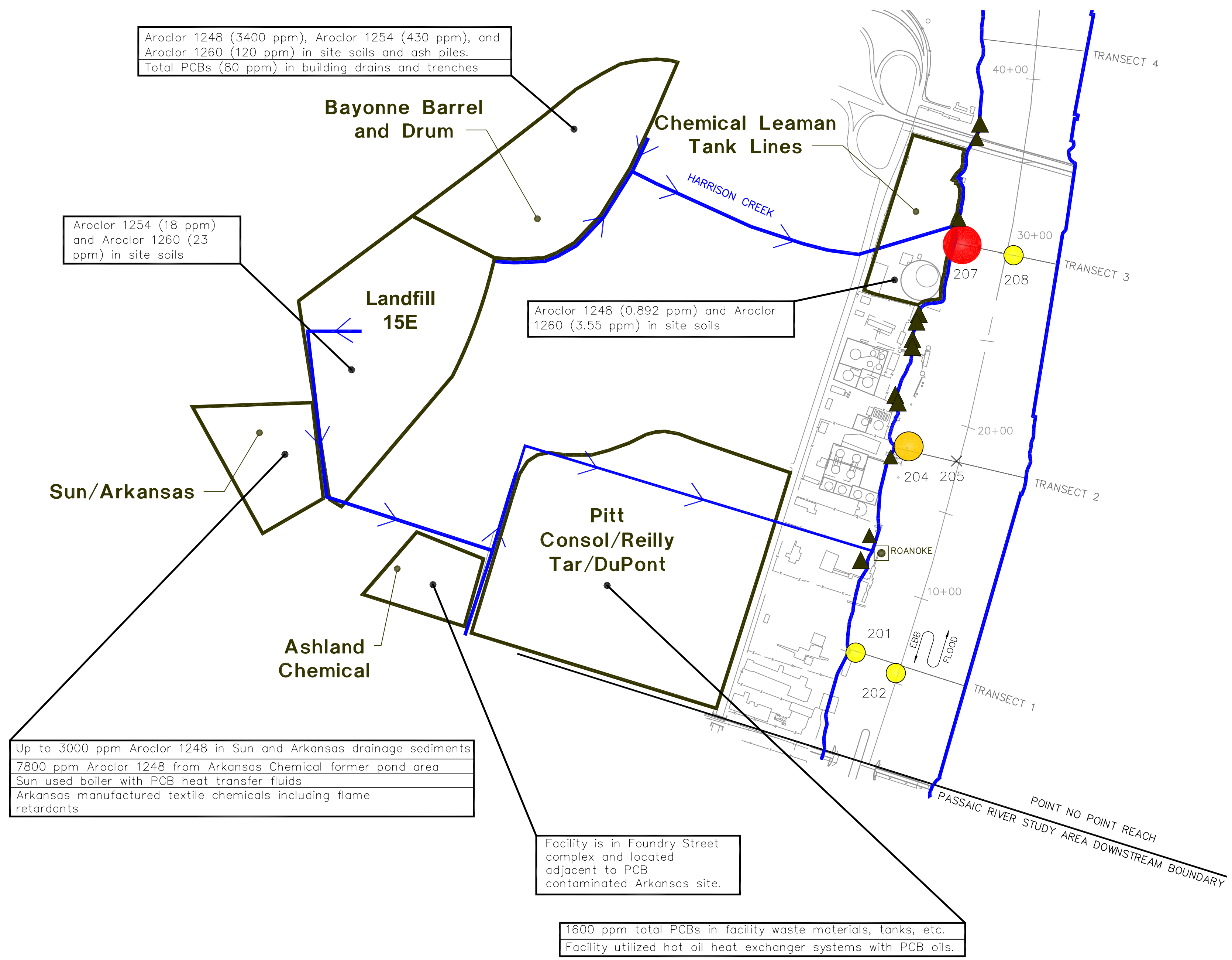
PCB PRP Locations and PCB Source Areas Along Point No Point Reach Western Riverbank



LEGEND:

- EBB / FLOOD — TIDALLY INFLUENCED FLOW
- STORM SEWER OUTFALL
- CSO OUTFALL
- HISTORIC AND PRESENT DAY OUTFALLS
- PRP FACILITY OUTLINES
- HIGHEST PCB AROCLOR OR CONGENER CONCENTRATION
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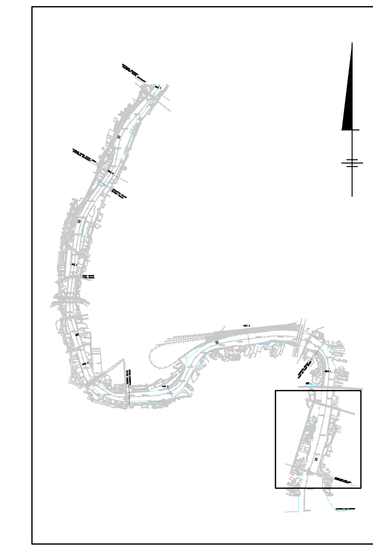
- 208 — RI CORE BORING LOCATION
- TRIBUTARY OR DISCHARGE ROUTE TO THE PASSAIC RIVER
- UNDERGROUND FLOW ROUTE
- TRANSECT 8 — 1995 RI SEDIMENT SAMPLING TRANSECT
- 230+00 — USACE RIVER STATIONING



Core 201

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20101A			BZ169	0.078
20106A	1248	3150	BZ105	91
			BZ118	230

Core 202

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20205E			BZ105	60
			BZ118	170
			BZ157	5
20206E			BZ77	30
			BZ105	67
			BZ118	220
			BZ156	22
			BZ157	6.4

Core 204

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20405A	1248	4910	BZ77	68
	1254	2040	BZ105	100
			BZ114	9.9
			BZ118	205
			BZ118	240
			BZ156	24
			BZ157	4.7
			BZ167	30
			BZ189	1.7
20406A	1248	21900	BZ77	360
	1254	7070	BZ105	530
			BZ114	58
			BZ118	1100
			BZ118	685
			BZ126	3.9
			BZ156	110
			BZ157	22
			BZ167	91
			BZ189	5.7

Core 207

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20702A	1260	2110	BZ77	37
			BZ105	130
			BZ114	10
			BZ118	400
			BZ126	1.5
			BZ156	56
			BZ157	13
			BZ167	36
			BZ169	0.097
			BZ189	3.5
20703A	1248	5100	BZ77	100
	1254	5630	BZ105	450
			BZ114	53
			BZ118	682
			BZ118	1600
			BZ126	3.3
			BZ156	90
			BZ157	25
			BZ167	68
			BZ169	0.086
			BZ189	6.1
20704A	1248	5310	BZ77	32
	1254	18100	BZ105	780
			BZ114	69
			BZ118	2480
			BZ118	2200
			BZ126	4.2
			BZ156	180
			BZ157	47
			BZ167	190
			BZ169	0.079
			BZ189	8.3

Core 208

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
20802A	1248	2570	BZ77	62
			BZ105	98
			BZ114	8.8
			BZ118	250
			BZ156	23
			BZ157	5.7
			BZ169	0.063

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GRAPHIC SCALE

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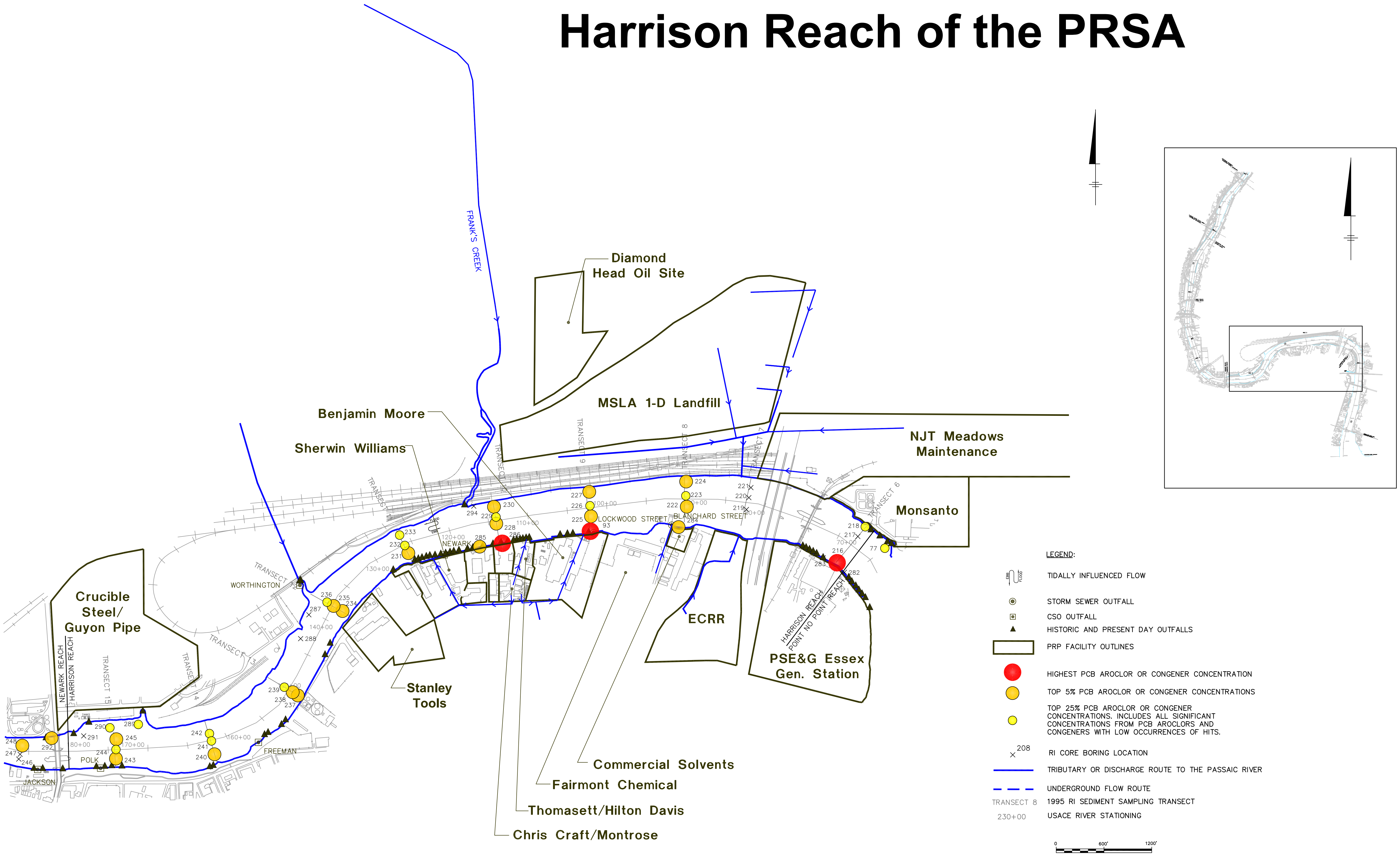
PCB PRP Locations and PCB Source Areas in Harrison Reach of the PRSA



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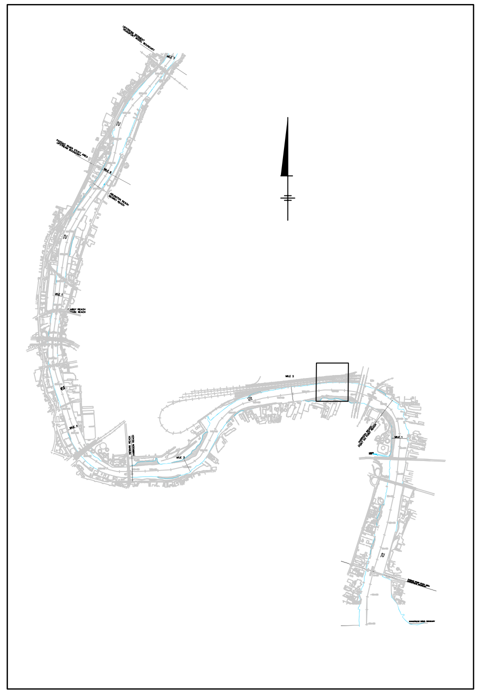
PCB PRP Locations and PCB Source Areas Along Harrison Reach Northeastern Riverbank



Core 223

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22304A	1248	4370	BZ77	32
	1254	2480	BZ105	100
			BZ114	11
			BZ118	199
			BZ118	270
			BZ126	0.84
			BZ156	34
			BZ157	6.2
			BZ167	43
22305A	1254	2380	BZ105	96
			BZ114	9.5
			BZ118	240
			BZ156	31
			BZ157	6
			BZ167	37
22306A	1248	3420	BZ77	37
	1254	2420	BZ105	110
			BZ114	11
			BZ118	208
			BZ118	290
			BZ126	0.97
			BZ156	39
			BZ157	9.1
			BZ167	52

Core 224

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22402A	1248	2860	BZ77	61
			BZ105	77
			BZ114	7.5
			BZ118	337
			BZ118	220
			BZ126	0.85
			BZ167	29
			BZ189	1.8
22403A	1248	5430	BZ77	88
	1254	3250	BZ105	150
			BZ114	17
			BZ118	380
			BZ118	385
			BZ126	1.4
			BZ156	35
			BZ157	7
			BZ167	52
			BZ189	3.1
22404A	1248	5430	BZ77	92
	1254	4740	BZ105	170
			BZ114	16
			BZ118	324
			BZ118	400
			BZ126	1.3
			BZ156	41
			BZ157	8.2
			BZ167	53
			BZ189	3
22405A			BZ77	120
			BZ105	180
			BZ114	16
			BZ118	390
			BZ126	1.1
			BZ156	41
			BZ157	8.1
			BZ167	57
			BZ189	3
22406A	1248	4720	BZ77	74
	1254	4320	BZ105	190
			BZ114	20
			BZ118	470
			BZ118	434
			BZ126	1.2
			BZ156	51
			BZ157	9.7
			BZ167	64
			BZ189	4.5

Core 226

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22603A	1254	2180	BZ77	50
			BZ105	83
			BZ114	8.4
			BZ118	220
			BZ126	0.94
			BZ156	23
			BZ157	4.6
			BZ167	33
			BZ189	2.4
22604A	1248	3340	BZ77	63
	1254	2990	BZ105	130
			BZ114	12
			BZ118	340
			BZ118	291
			BZ126	1
			BZ156	33
			BZ157	6.6
			BZ167	43
			BZ189	2.9
22605A	1248	2960	BZ77	46
	1254	3320	BZ105	120
			BZ114	12
			BZ118	320
			BZ126	0.86
			BZ156	34
			BZ157	7
			BZ167	37
			BZ189	2.9

Core 227

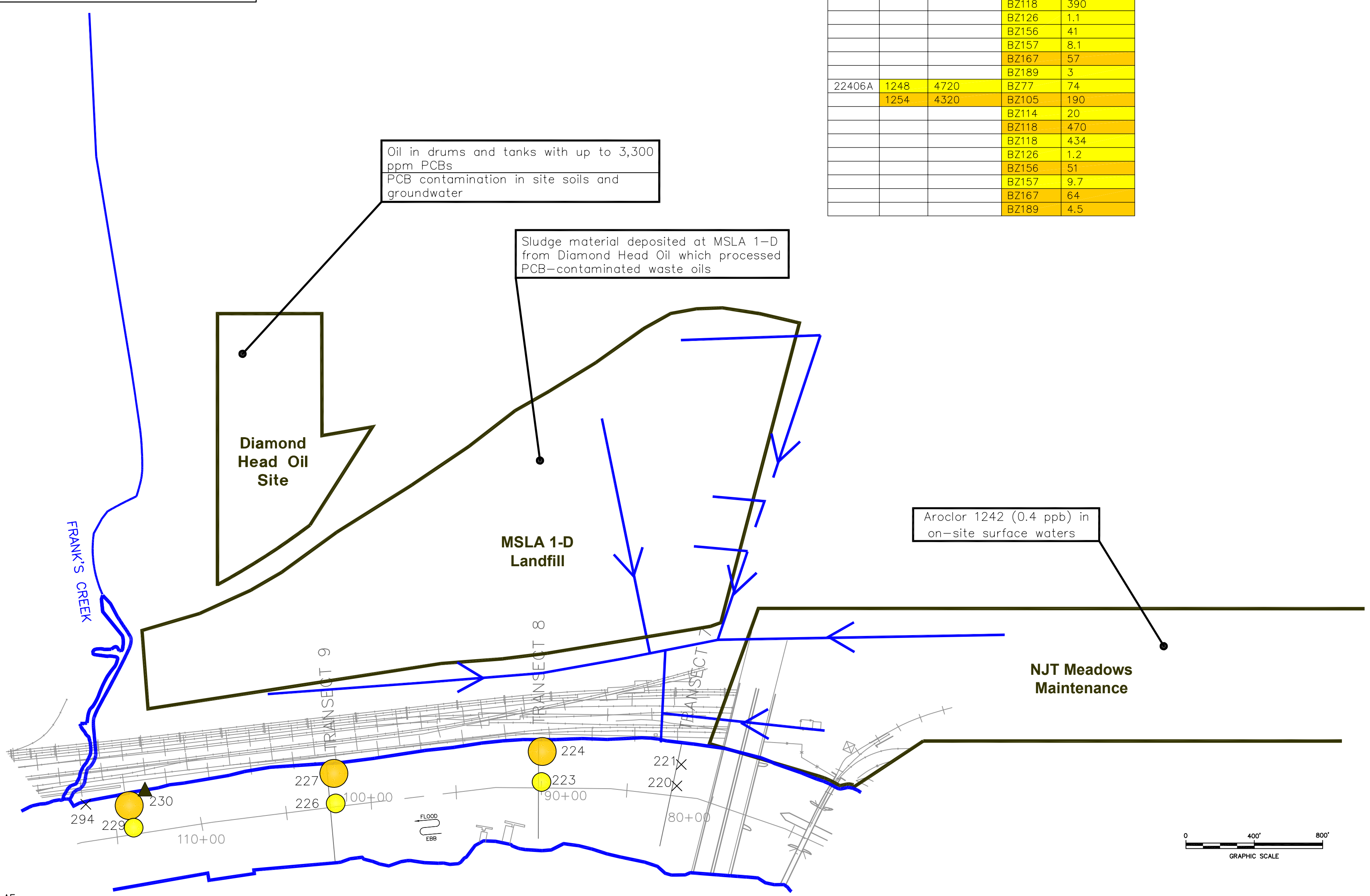
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22701A			BZ77	34
			BZ105	72
			BZ118	190
			BZ156	20
22702A	1248	2280	BZ77	61
	1254	1660	BZ105	110
			BZ114	12
			BZ118	330
			BZ126	1.1
			BZ156	30
			BZ157	6.3
			BZ167	44
22703A	1248	3780	BZ77	68
	1254	2960	BZ105	150
			BZ114	15
			BZ118	350
			BZ126	1.2
			BZ156	38
			BZ157	7.4
			BZ167	56
			BZ189	1.7
22704A	1248	5690	BZ77	100
	1254	4730	BZ105	220
			BZ114	21
			BZ118	510
			BZ118	344
			BZ126	1.7
			BZ156	57
			BZ157	12
			BZ167	62
			BZ189	2.3
22705A	1248	3800	BZ77	92
	1254	2550	BZ105	250
			BZ114	26
			BZ118	600
			BZ126	1.6
			BZ156	69
			BZ157	15
			BZ167	70
			BZ189	2.9
22706A	1254	2660	BZ77	42
			BZ105	120
			BZ114	11
			BZ118	330
			BZ126	0.86
			BZ156	38
			BZ157	7.9
			BZ167	46
			BZ189	2.3

Core 229

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22904A			BZ105	84
			BZ114	8.3
			BZ118	230
			BZ126	0.95
			BZ157	4.5
			BZ167	36
			BZ189	1.9
22905A	1248	2370	BZ77	59
			BZ105	120
			BZ114	12
			BZ118	330
			BZ156	31
			BZ157	6.2
			BZ167	47
			BZ189	2.4
22906A	1248	2500	BZ77	85
			BZ105	180
			BZ114	16
			BZ118	440
			BZ126	1.4
			BZ156	45
			BZ157	9
			BZ167	49
			BZ189	3.3

Core 230

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
23004A	1248	2520	BZ77	40
			BZ105	88
			BZ114	9.2
			BZ118	210
			BZ156	23
			BZ167	33
23005A	1254	2040	BZ77	67
			BZ105	100
			BZ114	11
			BZ118	250
			BZ126	1.1
			BZ156	27
			BZ157	4.9
			BZ167	38
23006A	1248	3350	BZ77	85
	1254	2670	BZ105	170
			BZ114	17
			BZ118	400
			BZ118	266
			BZ126	1.3
			BZ156	46
			BZ157	9.6
			BZ167	55
			BZ189	2.4
23007A			BZ105	79
			BZ114	7.2
			BZ118	481
			BZ118	210
			BZ156	24
			BZ157	4.7
			BZ167	31



LEGEND:

- TIDALLY INFLUENCED FLOW
- STORM SEWER OUTFALL
- CSO OUTFALL
- HISTORIC AND PRESENT DAY OUTFALLS
- PRP FACILITY OUTLINES
- HIGHEST PCB AROCLOR OR CONGENER CONCENTRATION
- TOP 5% PCB AROCLOR OR CONGENER CONCENTRATIONS
- TOP 25% PCB AROCLOR OR CONGENER CONCENTRATIONS. INCLUDES ALL SIGNIFICANT CONCENTRATIONS FROM PCB AROCLORS AND CONGENERS WITH LOW OCCURRENCES OF HITS.
- 208 RI CORE BORING LOCATION
- TRIBUTARY OR DISCHARGE ROUTE TO THE PASSAIC RIVER
- UNDERGROUND FLOW ROUTE
- TRANSECT 8 1995 RI SEDIMENT SAMPLING TRANSECT
- 230+00 USACE RIVER STATIONING

X: 09994XR2, 09994X13
L: ON=*, OFF=*REF*
P: PAGESET/DL
8/20/02 SYR-54-SDL GMS LAF
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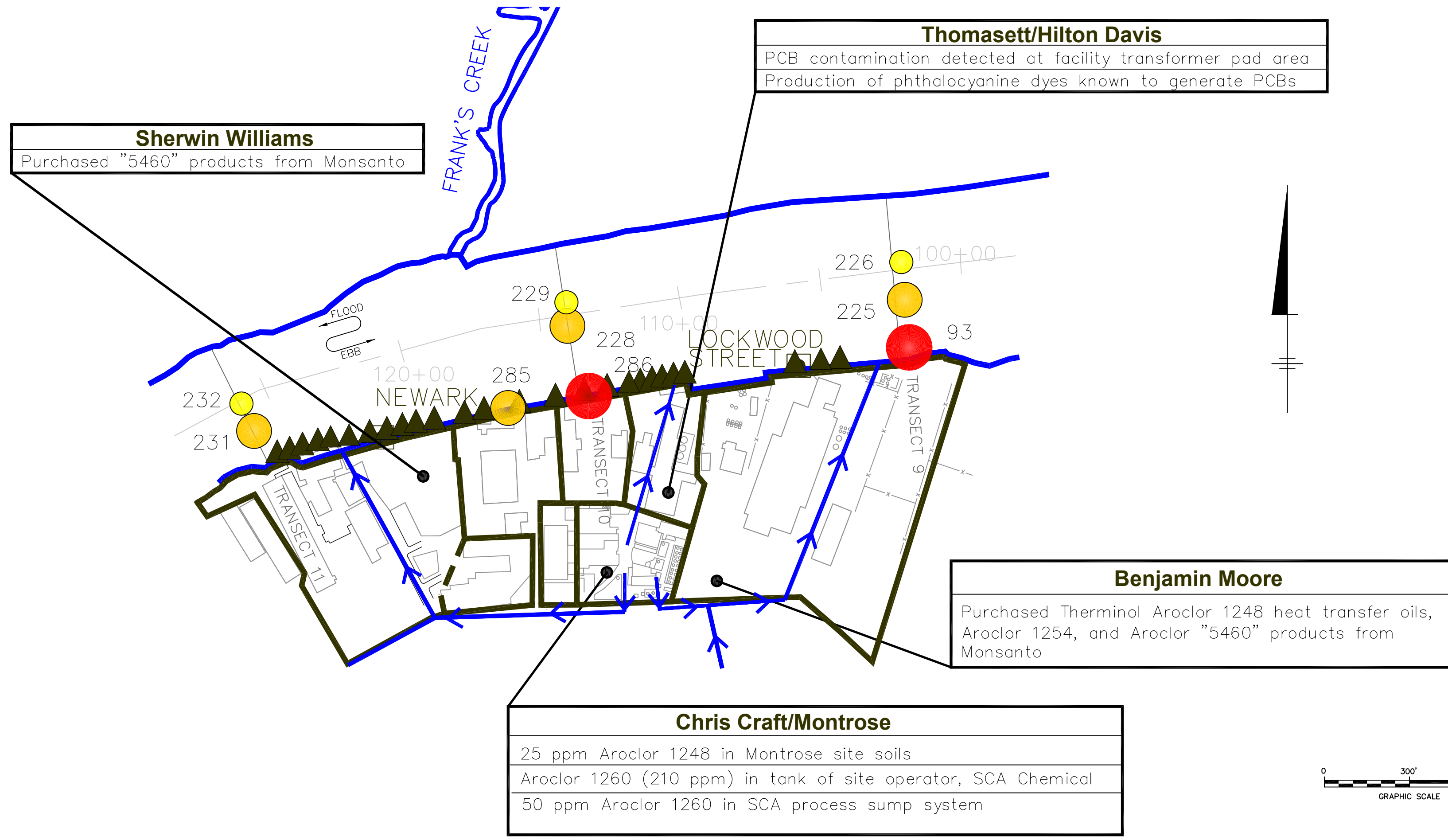
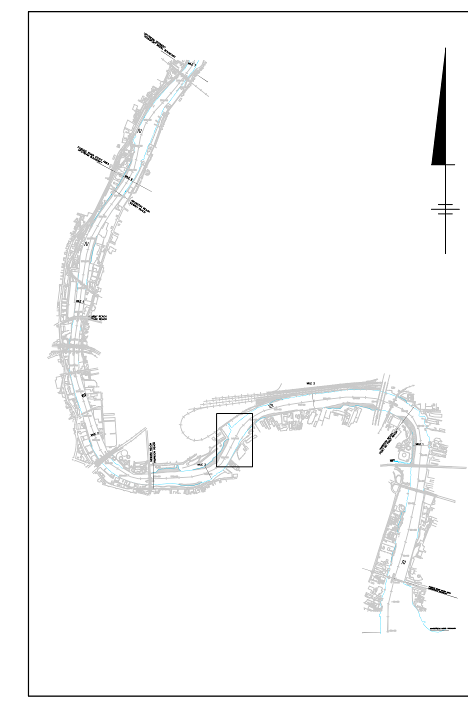
PCB PRP Locations and PCB Source Areas Along Harrison Reach Southwestern Riverbank



LEGEND:

- EBB FLOOD — TIDALLY INFLUENCED FLOW
- STORM SEWER OUTFALL
- CSO OUTFALL
- HISTORIC AND PRESENT DAY OUTFALLS
- PRP FACILITY OUTLINES
- HIGHEST PCB AROCLOR OR CONGENER CONCENTRATION
- TOP 5% PCB AROCLOR OR CONGENER CONCENTRATIONS
- TOP 25% PCB AROCLOR OR CONGENER CONCENTRATIONS. INCLUDES ALL SIGNIFICANT CONCENTRATIONS FROM PCB AROCLORS AND CONGENERS WITH LOW OCCURRENCES OF HITS.
- 208 — RI CORE BORING LOCATION
- TRIBUTARY OR DISCHARGE ROUTE TO THE PASSAIC RIVER
- UNDERGROUND FLOW ROUTE
- TRANSECT 8 — 1995 SEDIMENT SAMPLING TRANSECT
- 230+00 — USACE RIVER STATIONING

0 300' 600'
GRAPHIC SCALE



Core 93

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
93A001			BZ169	0.078
93A024	1248	47700	BZ77	320
			BZ105	170
			BZ118	220
			BZ126	5
			BZ169	0.33
93A040			BZ77	33
			BZ126	1.8

Core 225

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22503A			BZ77	37
			BZ105	76
			BZ114	7.9
			BZ118	220
			BZ156	24
			BZ157	4.7
			BZ167	36
22504A	1254	1710	BZ77	73
			BZ105	160
			BZ114	17
			BZ118	410
			BZ126	1.3
			BZ156	41
			BZ157	7.8
			BZ167	46
			BZ189	2.1
22505A	1248	2880	BZ77	57
			BZ105	130
			BZ114	13
			BZ118	811
			BZ118	330
			BZ126	1
			BZ156	36
			BZ157	7.1
			BZ167	43
			BZ189	1.9
22506A			BZ118	734

Core 226

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22603A	1254	2180	BZ77	50
			BZ105	83
			BZ114	8.4
			BZ118	220
			BZ126	0.94
			BZ156	23
			BZ157	4.6
			BZ167	33
			BZ189	2.4
22604A	1248	3340	BZ77	63
	1254	2990	BZ105	130
			BZ114	12
			BZ118	340
			BZ118	291
			BZ126	1
			BZ156	33
			BZ157	6.6
			BZ167	43
			BZ189	2.9
22605A	1248	2960	BZ77	46
	1254	3320	BZ105	120
			BZ114	12
			BZ118	320
			BZ126	0.86
			BZ156	34
			BZ157	7
			BZ167	37
			BZ189	2.9

Core 228

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22803B			BZ77	94
			BZ105	100
			BZ114	11
			BZ118	290
			BZ126	1.1
			BZ156	29
			BZ157	6.7
			BZ189	1.7
22804B	1254	1730	BZ77	47
			BZ105	100
			BZ114	10
			BZ118	270
			BZ156	27
			BZ157	5.9
			BZ189	1.7
22805B	1254	1780		

Core 229

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
22904A			BZ77	40
			BZ105	84
			BZ114	8.3
			BZ118	230
			BZ126	0.95
			BZ157	4.5
			BZ167	36
			BZ189	1.9
22905A	1248	2370	BZ77	59
			BZ105	120
			BZ114	12
			BZ118	330
			BZ156	31
			BZ157	6.2
			BZ167	47
			BZ189	2.4
22906A	1248	2500	BZ77	85
			BZ105	180
			BZ114	16
			BZ118	440
			BZ126	1.4
			BZ156	45
			BZ157	9
			BZ167	49
			BZ189	3.3

Core 231

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
23103A	1248	4260	BZ77	63
	1254	3110	BZ105	140
			BZ114	14
			BZ118	360
			BZ118	249
			BZ126	1.7
			BZ156	39
			BZ157	9.2
			BZ167	36
			BZ189	1.9
23104A	1248	2410	BZ77	79
			BZ105	190
			BZ114	20
			BZ118	480
			BZ126	1.8
			BZ156	51
			BZ157	12
			BZ167	54
			BZ189	2.4
23105A			BZ77	40
			BZ105	150
			BZ114	15
			BZ118	390
			BZ126	1.1
			BZ156	45
			BZ157	11
			BZ167	43
23106A			BZ118	457

Core 232

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
23204A			BZ105	65
			BZ118	180
			BZ156	24
			BZ157	5.3
			BZ167	31

Core 285

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
28502A			BZ77	29
			BZ118	310
28503A	1242	5580	BZ77	45
			BZ105	150
			BZ114	13
			BZ118	410
			BZ118	1790
			BZ126	2.6
			BZ156	42
			BZ157	11
			BZ167	42
			BZ189	2.8
28504A	1248	3670	BZ77	50
			BZ105	66
			BZ118	469
			BZ118	230
			BZ126	1.2
			BZ156	21
			BZ157	4.8
			BZ167	28
			BZ189	2.6
28505A	1248	3540	BZ77	100
			BZ105	130
			BZ114	13
			BZ118	370
			BZ126	1.2
			BZ156	28
			BZ157	6.2
			BZ167	36
			BZ189	2.6
28506A			BZ77	200
			BZ105	340
			BZ114	19
			BZ118	530
			BZ126	4.8

Core 286

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
28603B	1248	3640	BZ77	42
			BZ105	120
			BZ114	10
			BZ118	340
			BZ126	1.2
			BZ156	34
			BZ157	8.9
			BZ167	34
			BZ189	2.6
28604B	1248	3920	BZ77	84
	1254	3110	BZ105	110
			BZ114	9.7
			BZ118	330
			BZ126	1.2
			BZ156	24
			BZ157	5.3
			BZ167	34
			BZ189	2.4
28605B	1248	15700	BZ77	260
			BZ105	450
			BZ114	41
			BZ118	1100
			BZ126	3.2
			BZ156	36
			BZ157	8.5
			BZ167	34
			BZ189	5.9
28606B			BZ77	58
			BZ105	130
			BZ114	13
			BZ118	360
			BZ126	5.5
			BZ156	47
			BZ157	5.5
			BZ167	120
			BZ169	0.49
			BZ189	13

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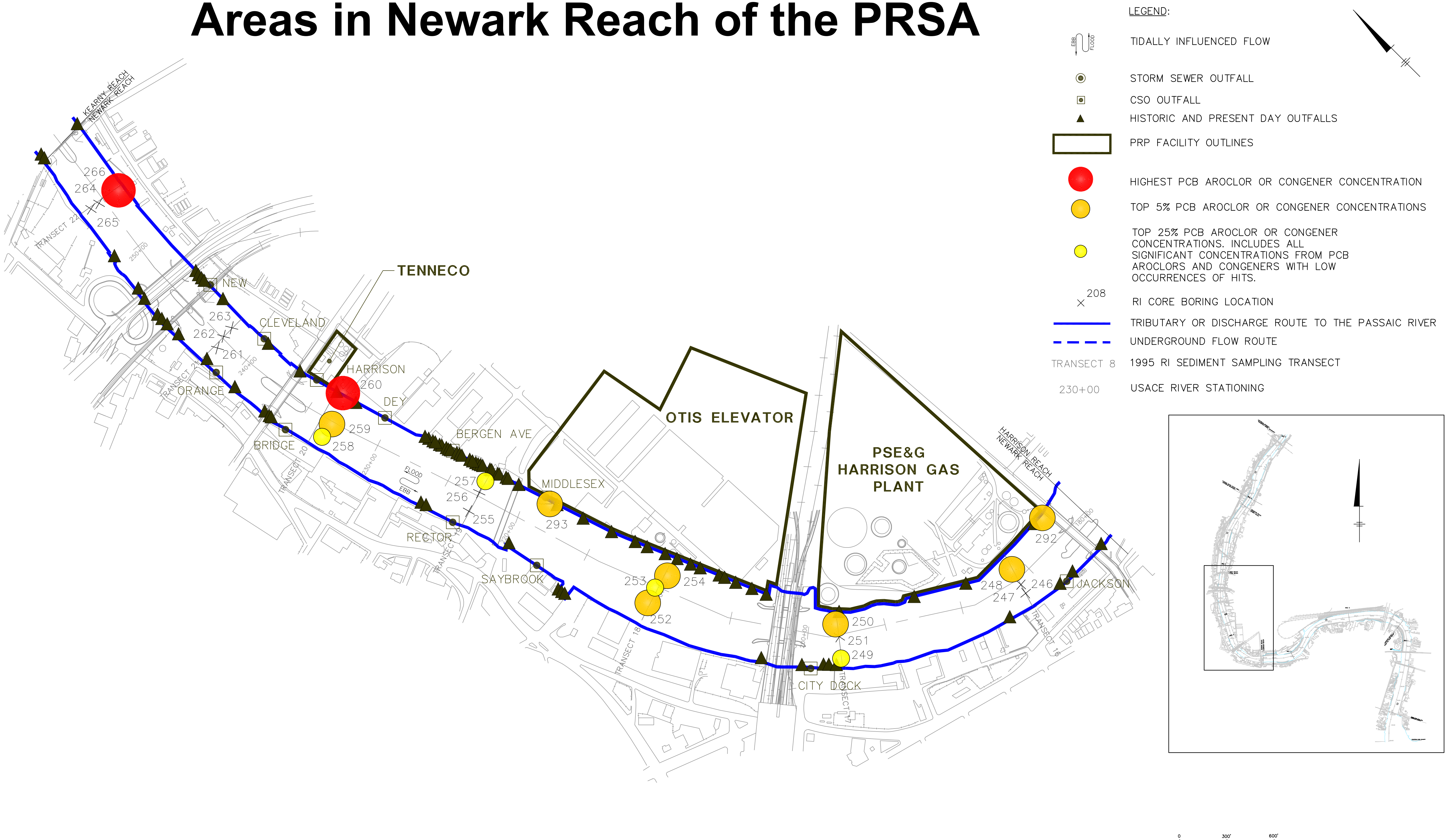
8/20/02 SYR-54-SDL GMS LAF
09994063/PRSA/09994G33.DWG

PCB PRP Locations and PCB Source Areas in Newark Reach of the PRSA



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8/20/02 SYR-54-SDL GMS LAF
09994063/PRSA/09994G27.DWG

PCB PRP Locations and PCB Source Areas Along Newark Reach Eastern Riverbank

Core 248

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
24803A	1248	3750	BZ77	91
	1254	3440	BZ105	170
			BZ114	17
			BZ118	430
			BZ118	296
			BZ126	1.5
			BZ156	47
			BZ157	10
			BZ167	44
			BZ189	2.4
24804A			BZ77	34
			BZ105	70
			BZ118	180

Core 251

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
25101B			BZ189	4.2
25103B	1248	2250	BZ77	37
			BZ105	86
			BZ114	8.9
			BZ118	240
			BZ156	26
			BZ157	5.2
			BZ167	32
			BZ189	3.3
25104B	1248	5390	BZ77	64
	1254	2990	BZ105	170
			BZ114	17
			BZ118	283
			BZ118	400
			BZ126	0.94
			BZ156	41
			BZ157	9.2
			BZ167	37
			BZ189	3.1
25105B	1248	4110	BZ77	48
	1254	2240	BZ105	130
			BZ114	14
			BZ118	320
			BZ118	215
			BZ126	1
			BZ156	32
			BZ157	6.8
			BZ167	30
			BZ189	2.7

Core 253

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
25304A	1260	827	BZ77	30
			BZ105	65
			BZ118	160

Core 254

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
25401A	1260	685	BZ156	41
			BZ167	48
			BZ189	12
25405A			BZ77	39
			BZ105	100
			BZ114	10
			BZ118	260
			BZ156	26
			BZ157	5.5
			BZ167	28
			BZ189	2

Core 292

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
29202C	1248	2500	BZ105	61
29204C			BZ118	180
29205C	1248	2770	BZ77	63
	1254	2210	BZ105	99
			BZ114	8.7
			BZ118	290
			BZ126	0.99
			BZ156	27
			BZ157	7.2
29206C	1248	18400	BZ77	81
	1254	15800	BZ105	130
			BZ114	11
			BZ118	360
			BZ126	1.1
			BZ156	33
			BZ157	8
			BZ167	28
			BZ189	1.7

Core 293

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
29301A			BZ156	72
			BZ167	36

LEGEND:

- EBB / FLOOD — TIDALLY INFLUENCED FLOW
- STORM SEWER OUTFALL
- CSO OUTFALL
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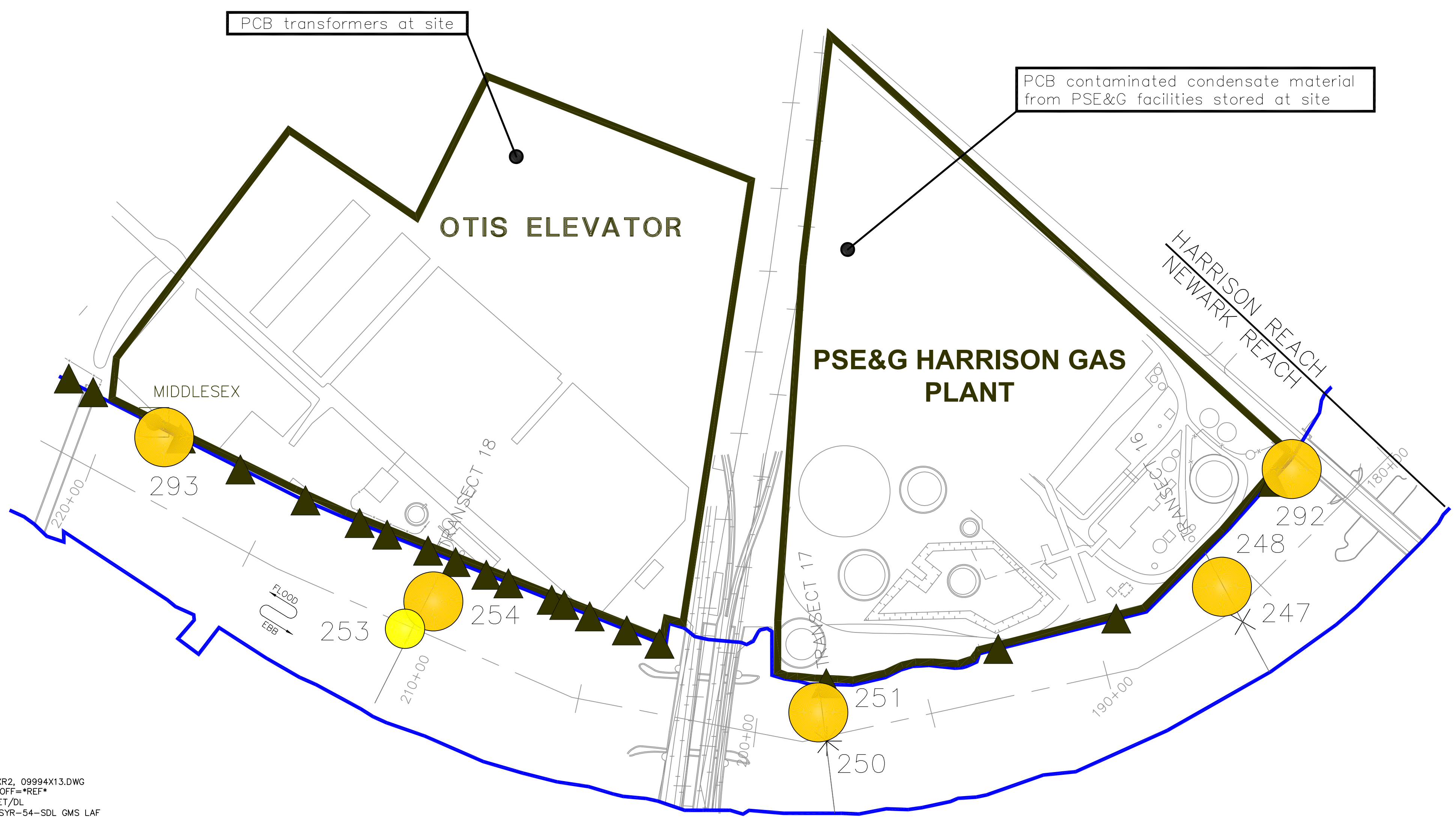
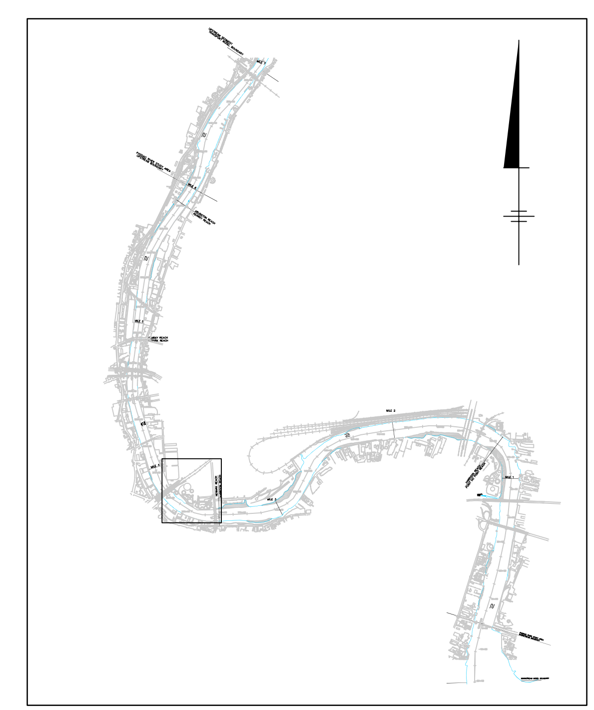
- PRP FACILITY OUTLINES
- HIGHEST PCB AROCLOR OR CONGENER CONCENTRATION
- TOP 5% PCB AROCLOR OR CONGENER CONCENTRATIONS
- TOP 25% PCB AROCLOR OR CONGENER CONCENTRATIONS. INCLUDES ALL SIGNIFICANT CONCENTRATIONS FROM PCB AROCLORS AND CONGENERS WITH LOW OCCURRENCES OF HITS.
- 208 — RI CORE BORING LOCATION
- TRIBUTARY OR DISCHARGE ROUTE TO THE PASSAIC RIVER
- UNDERGROUND FLOW ROUTE
- TRANSECT 8 — 1995 RI SEDIMENT SAMPLING TRANSECT
- 230+00 — USACE RIVER STATIONING





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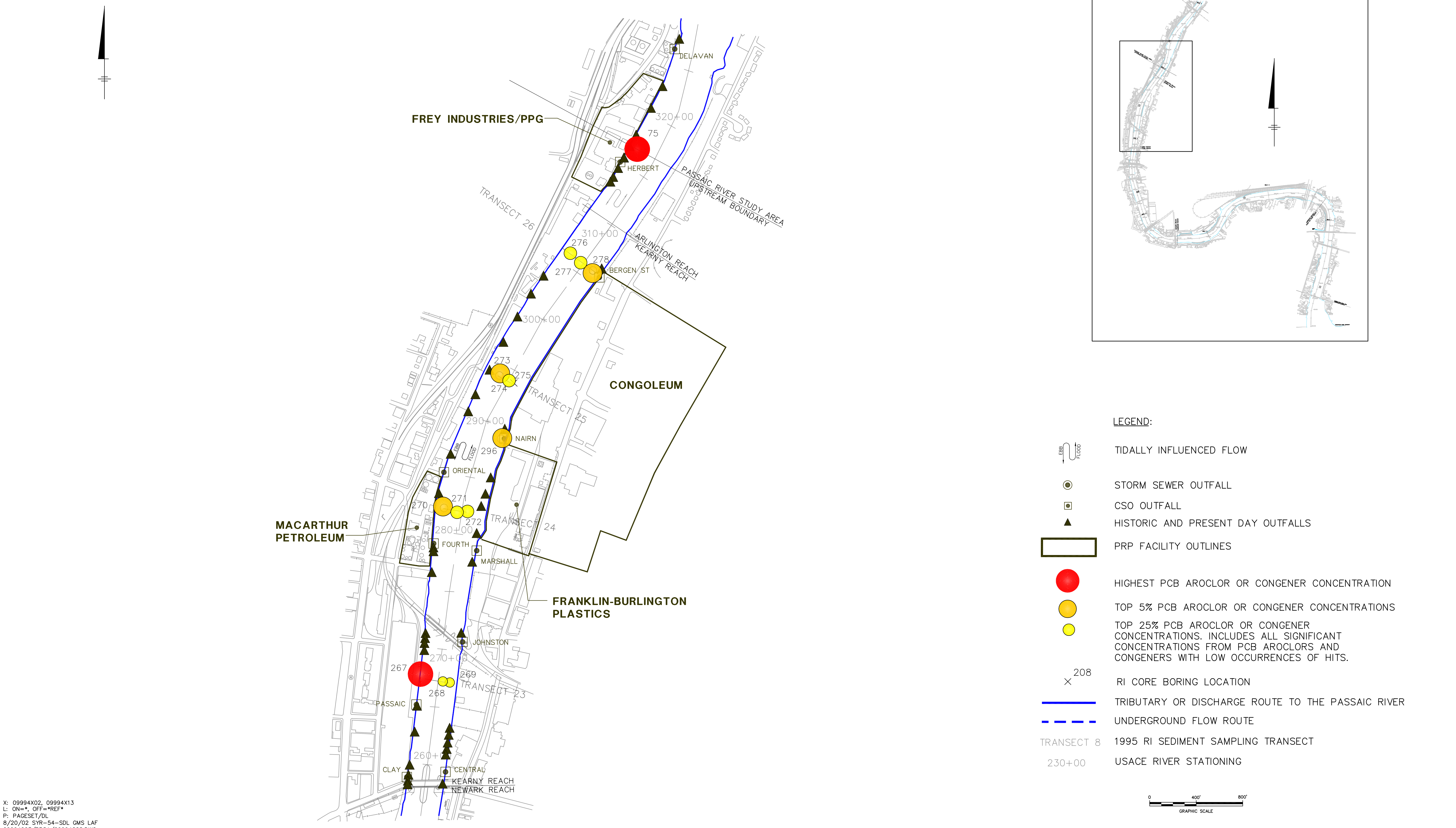
PCB PRP Locations and PCB Source Areas in Kearny and Arlington Reaches of the PRSA



PCB PRP Locations and PCB Source Areas Along Kearny Reach Western Riverbank

Core 267

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
26701A	1242	17200	BZ77	63
			BZ105	75
			BZ114	10
			BZ118	240
			BZ118	846
			BZ189	1.7
26702A	1254	2430	BZ77	29
			BZ118	284

Core 268

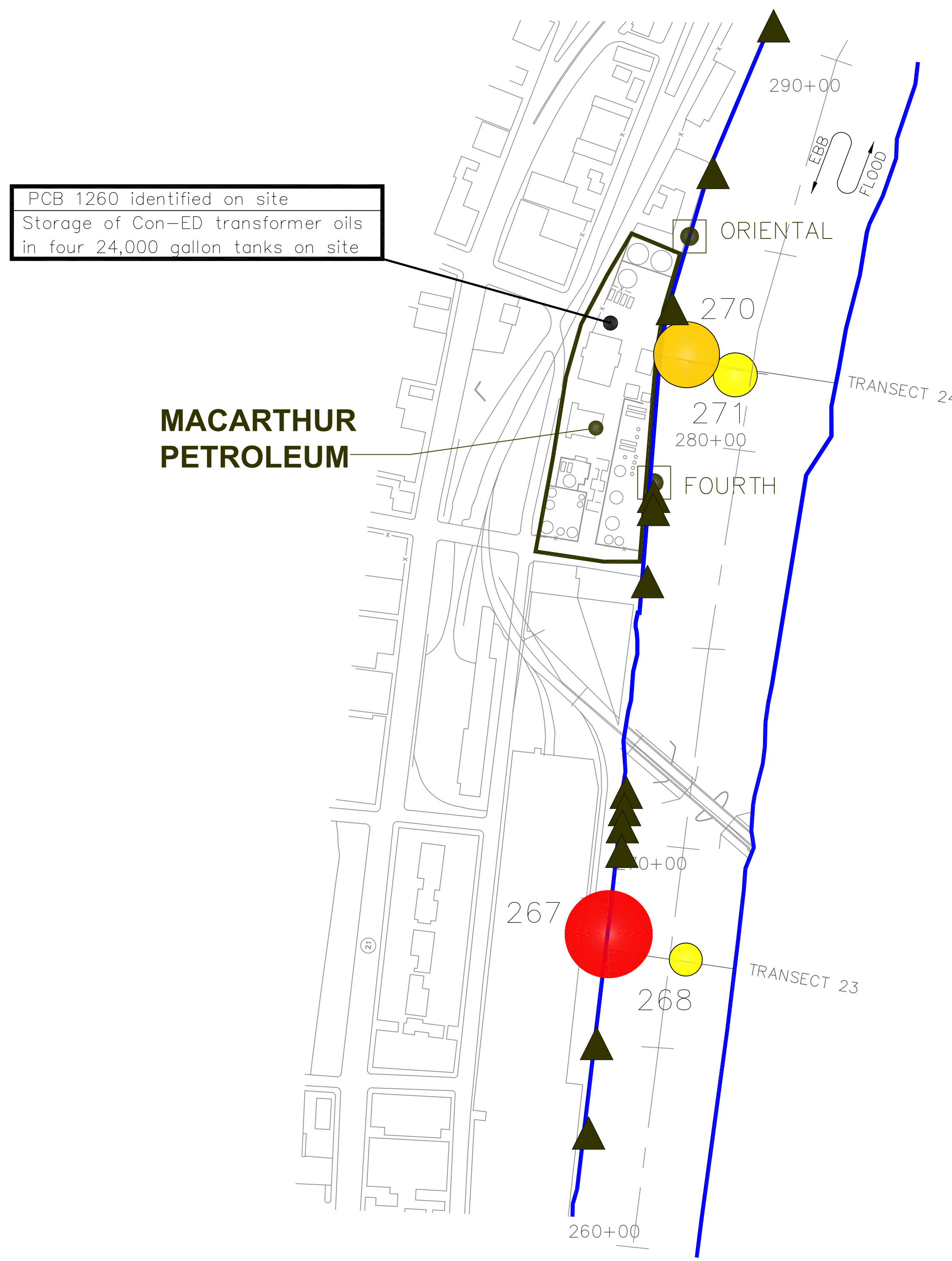
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
26802B			BZ77	45
26803B			BZ77	40

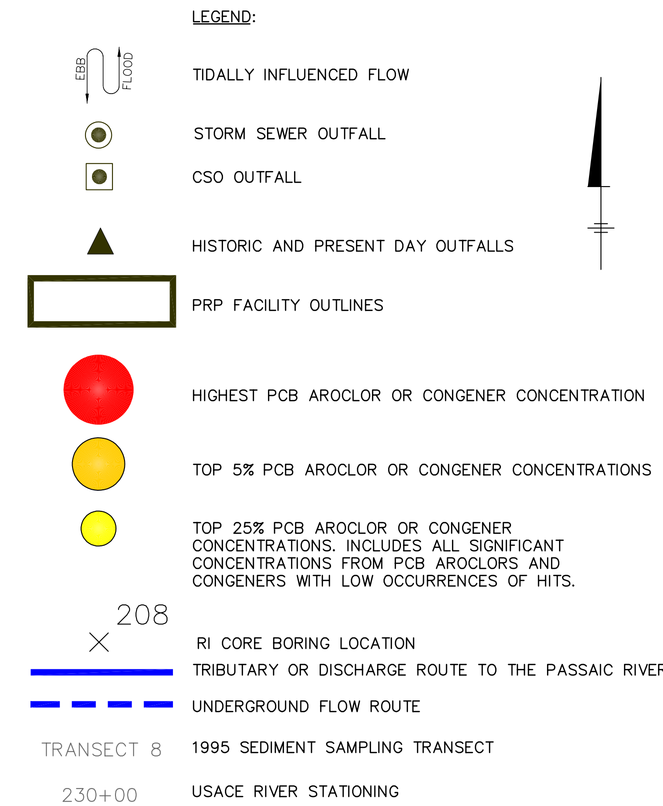
Core 270

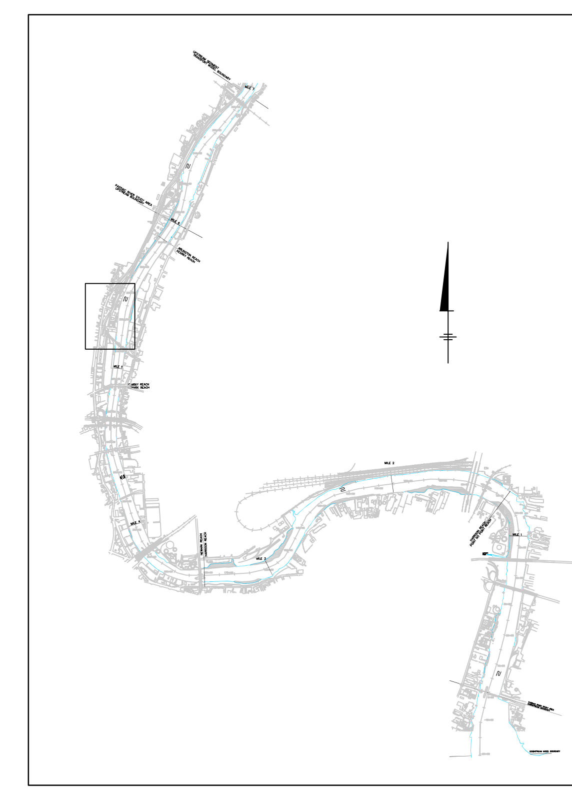
Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
27001A			BZ189	4.1
27002A	1242	6150	BZ105	94
	1254	3660	BZ114	9.8
			BZ118	250
			BZ118	197
			BZ156	32
			BZ157	6.2
			BZ167	42
			BZ189	2.9
27003A	1260	3120	BZ77	63
			BZ105	83
			BZ114	9.3
			BZ118	247
			BZ118	250
			BZ156	29
			BZ167	34
			BZ189	4.2
27004A	1248	7830	BZ77	93
	1254	6520	BZ105	200
			BZ114	21
			BZ118	321
			BZ118	470
			BZ126	1.6
			BZ156	44
			BZ157	8.7
			BZ167	61
			BZ189	2.2
27006A	1248	9460	BZ77	140
	1254	5940	BZ105	270
			BZ114	28
			BZ118	640
			BZ118	480
			BZ126	1.4
			BZ156	64
			BZ157	12
			BZ167	83
			BZ189	2.6

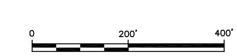
Core 271

Sample	Aroclor	Conc. (ppb)	Congener	Conc. (ppb)
27102A	1260	1020		
27103A	1254	2080	BZ77	34
			BZ105	67
			BZ114	7.2
			BZ118	190
			BZ167	30
			BZ189	1.8
27104A	1248	4860	BZ77	59
	1254	3560	BZ105	120
			BZ114	12
			BZ118	330
			BZ118	289
			BZ126	1.3
			BZ156	31
			BZ157	6.2
			BZ167	44
			BZ189	1.8









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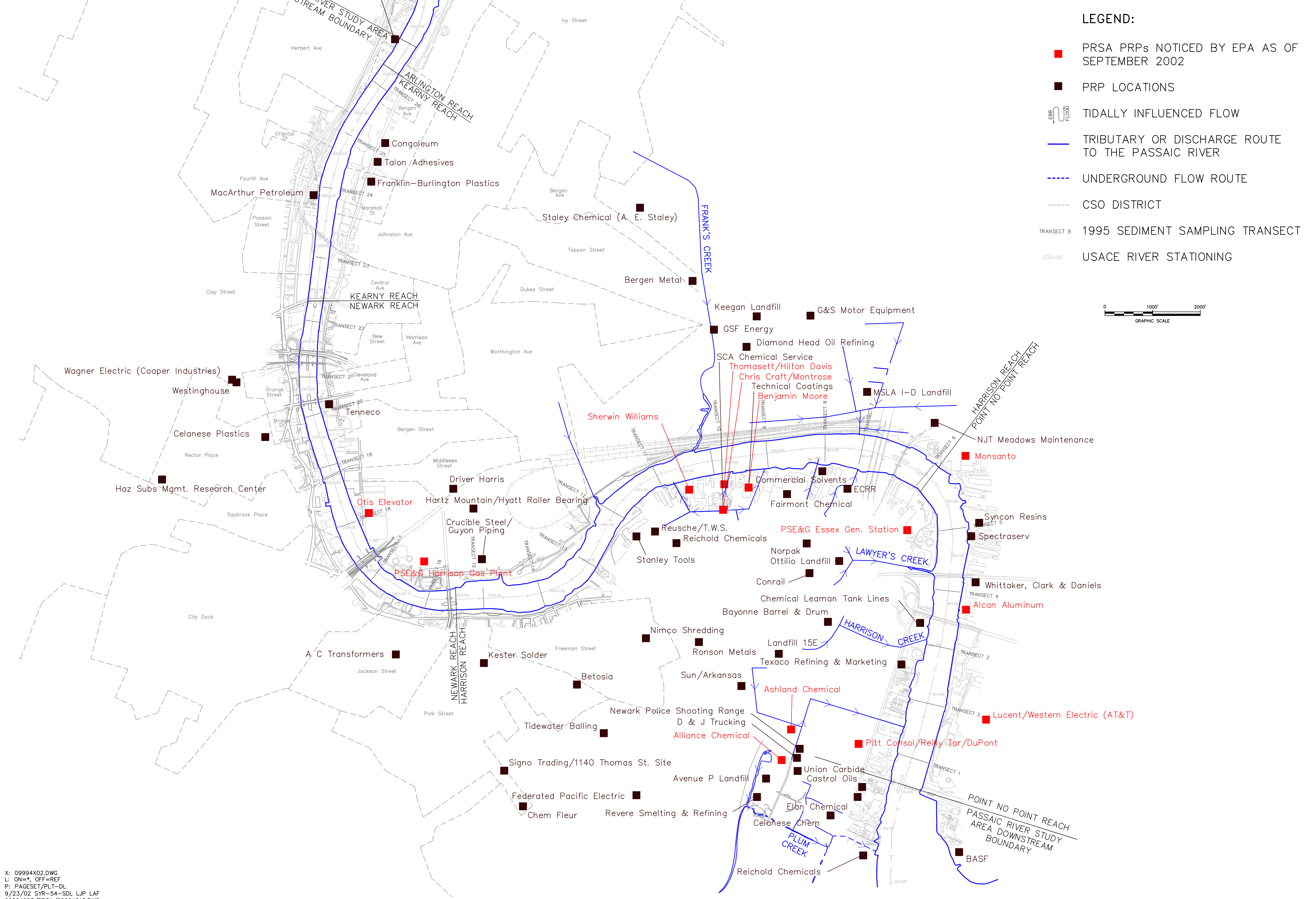
09994063/PRSA/09994G37.DWG

Conclusions: PCBs in the PRSA

- PRSA sediments contain elevated concentrations of PCBs.
- Numerous potential sources of PCBs to PRSA sediments have been identified – these "PRPs" include historical users and handlers of PCBs and PCB-contaminated products.
- PCB-contaminated soil and/or groundwater exist(s) at many of these PRPs' upland locations.
- Many of these PRP locations have historical and/or present day discharge pathways to the PRSA.
- Additional investigation will reveal more PRPs – both within the PRSA as well as the PRRI area.

TIERRA SOLUTIONS, INC.

PCB PRP Locations in the PRSA



PRP:
A.C. Transformers
Alcan Aluminum
Alliance Chemical
Ashland Chemical
Avenue P Landfill
BASF
Bayonne Barrel & Drum
Benjamin Moore
Bergen Metal
Betosia
Celanese Chem
Celanese Plastics
Chem Fleur
Chemical Leaman Tank Lines
Chris Craft/Montrose
Commercial Solvents
Congoleum
Conrail
Crucible Steel/Guyon Piping
D & J Trucking
Diamond Head Oil Refining
Driver Harris
ECRR
Elan Chemical
Fairmont Chemical
Federated Pacific Electric
Franklin–Burlington Plastics
Frey Industries/PPG
G&S Motor Equipment
GSF Energy
Hartz Mountain/Hyatt Roller Bearing
Haz Subs Mgmt. Research Center
Keegan Landfill
Kester Solder
Landfill 15E
Lucent/Western Electric (AT&T)
MacArthur Petroleum
Monsanto
MSLA I–D Landfill
Newark Police Shooting Range
Nimco Shredding
NJT Meadows Maintenance
Norpak
Otis Elevator
Ottilio Landfill
Pitt Consol/Reilly Tar/DuPont
PSE&G Essex Gen. Station
PSE&G Harrison Gas Plant
Reichold Chemicals
Reusche/T.W.S.
Revere Smelting & Refining
Ronson Metals
SCA Chemical Service
Sherwin Williams
Signo Trading/1140 Thomas St. Site
Spectraserv
Staley Chemical (A. E. Staley)
Stanley Tools
Sun/Arkansas
Syncon Resins
Talon Adhesives
Technical Coatings
Tenneco
Texaco Refining & Marketing
Thomasett/Hilton Davis
Tidewater Balling
Union Carbide Castrol Oils
Wagner Electric (Cooper Industries)
Westinghouse
Whittaker, Clark & Daniels

X: 09994X02.DWG
L: ON=*, OFF=REF
P: PAGESET/PLT–DL
9/23/02 SYR–54–SDL LJP LAF
09994063/PRSA/09994G12.DWG

For Next Time:

Presentation on Sources of Dioxin
in the PRRI Area

Facts Regarding Sources of Dioxin in the PRSA/PRRI Area

- There exist PRPs that handled products and employed processes utilizing chlorinated phenols – just like the former Diamond site.
- There exist PRPs that handled chemicals and employed processes identified by USEPA as associated with the formation of dioxins.
- Sampling for dioxins at these PRP locations has been limited; but dioxins were detected where sampling was conducted .
- Many of these PRP locations have historical and/or present day discharge pathways to the PRRI area.
- Additional investigation is required.

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Overview of Report on Sources of Dioxin in the Area

- Provides background on the formation of dioxins.
- Identifies more than 100 PRPs in the area associated with actual or likely dioxin generation.
- Provides evidence regarding 5 of these PRPs.

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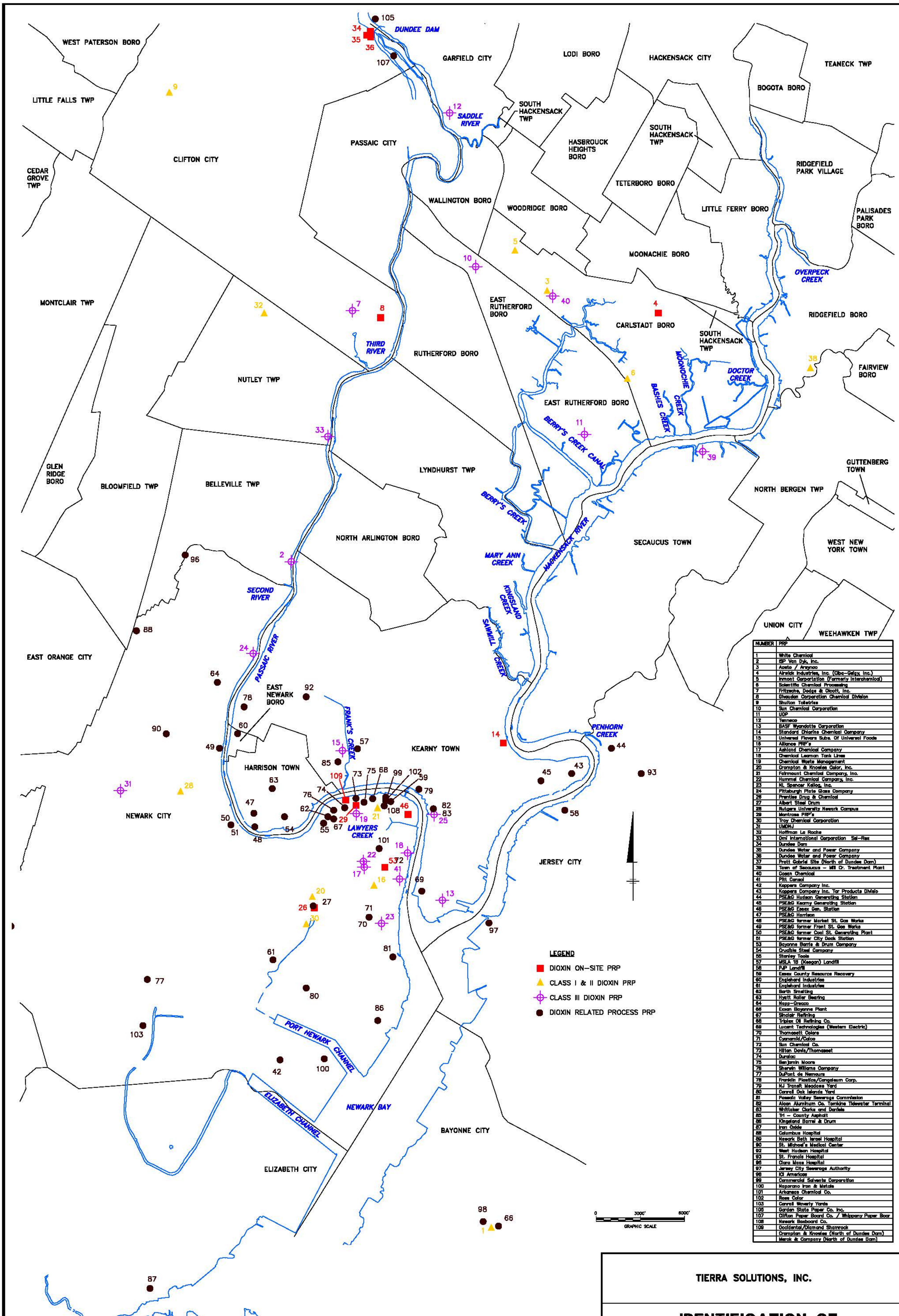

NUMBER	PRP
1	White Chemical
2	ISP Van Dyk, Inc.
3	Aceto / Arsynco
4	Airwick Industries, Inc. (Ciba-Geigy, Inc.)
5	Inmont Corportation (Formerly Interchemical)
6	Scientific Chemical Processing
7	Fritzsche, Dodge & Olcott, Inc.
8	Givaudan Corporation Chemical Division
9	Shulton Toiletries
10	Sun Chemical Corporation
11	UOP
12	Tenneco
13	BASF Wyandotte Corporation
14	Standard Chlorine Chemical Company
15	Universal Flavors Subs. Of Universal Foods
16	Alliance PRP's
17	Ashland Chemical Company
18	Chemical Leaman Tank Lines
19	Chemical Waste Management
20	Crompton & Knowles Color, Inc.
21	Fairmount Chemical Company, Inc.
22	Hummel Chemical Company, Inc.
23	NL Spencer Kellog, Inc.
24	Pittsburgh Plate Glass Company
26	Prentiss Drug & Chemical
27	Albert Steel Drum
28	Rutgers University Newark Campus
29	Montrose PRP's
30	Troy Chemical Corporation
31	UMDNJ
32	Hoffman La Roche
33	Omi International Corporation Sel-Rex
34	Dundee Dam
35	Dundee Water and Power Company
36	Dundee Water and Power Company
37	Pratt Gabriel Site (North of Dundee Dam)
39	Town of Secaucus - Mill Cr. Treatment Plant
40	Cosan Chemical
41	Pitt Consol
42	Koppers Company Inc.
43	Koppers Company Inc. Tar Products Divisio
44	PSE&G Hudson Generating Station
45	PSE&G Kearny Generating Station
46	PSE&G Essex Gen. Station
47	PSE&G Harrison
48	PSE&G former Market St. Gas Works
49	PSE&G former Front St. Gas Works
50	PSE&G former Coal St. Generating Plant
51	PSE&G former City Dock Station
53	Bayonne Barrle & Drum Company
54	Crucible Steel Company
55	Stanley Tools
57	MSLA 1B (Keegan) Landfill
58	PJP Landfill
59	Essex County Resource Recovery
60	Englehard Industries
61	Englehard Industries
62	Barth Smelting
63	Hyatt Roller Bearing
64	Napp-Grecco
66	Exxon Bayonne Plant
67	Sinclair Refining
68	Triplex Oil Refining Co.
69	Lucent Technologies (Western Electric)
70	Thomasett Colors
71	Cyanamid/Calco
72	Sun Chemical Co.
73	Hilton Davis/Thomasset
74	Duralac
75	Benjamin Moore
76	Sherwin Williams Company
77	DuPont de Nemours
78	Franklin Plastics/Congoleum Corp.
79	NJ Transit Meadows Yard
80	Conrail Oak Islands Yard
81	Passaic Valley Sewerage Commission
82	Alcan Aluminum Co. Tomkins Tidewater Terminal
83	Whittaker Clarks and Daniels
85	Tri - County Asphalt
86	Kingsland Barrel & Drum
87	Iron Oxide
88	Columbus Hospital
89	Newark Beth Israel Hospital
90	St. Michael's Medical Center
92	West Hudson Hospital
93	St. Francis Hospital
96	Clara Maas Hospital
97	Jersey City Sewerage Authority
98	ICI Americas
99	Commercial Solvents Corporation
100	Naporano Iron & Metals
101	Arkansas Chemical Co.
102	Ross Color
103	Conrail Waverly Yards
105	Garden State Paper Co. Inc.
107	Clifton Paper Board Co. / Whippany Paper Boar
108	Newark Boxboard Co.
109	Occidental/Diamond Shamrock
	Crompton & Knowles (North of Dundee Dam)
	Merck & Company (North of Dundee Dam)

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IDENTIFICATION OF DIOXIN SOURCES

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

DRAFT
CONFIDENTIAL WORK PRODUCT
PREPARED AT THE REQUEST OF, AND/OR
UNDER DIRECTION OF, LEGAL COUNSEL
IN ANTICIPATION OF LITIGATION

X: 09994X10.DWG
L: ON=* OFF=*REF*
P: PAGESET/PLT-DP
7/26/02 SYR-54-NES SDL LAF
09994023/09994G18.DWG

Habitat Characterization

Objectives

- Identify key habitats that remain in the PRSA
- Characterize/quantify shoreline habitats in the PRSA
- Delineate intertidal mudflats

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Methods

- Visual/videotape survey of shorelines throughout PRSA in Fall 1999 and Spring 2000
- Low and high tide surveys
- Classify/quantify shorelines into four categories – aquatic vegetation, bulkhead, riprap, mixed vegetation

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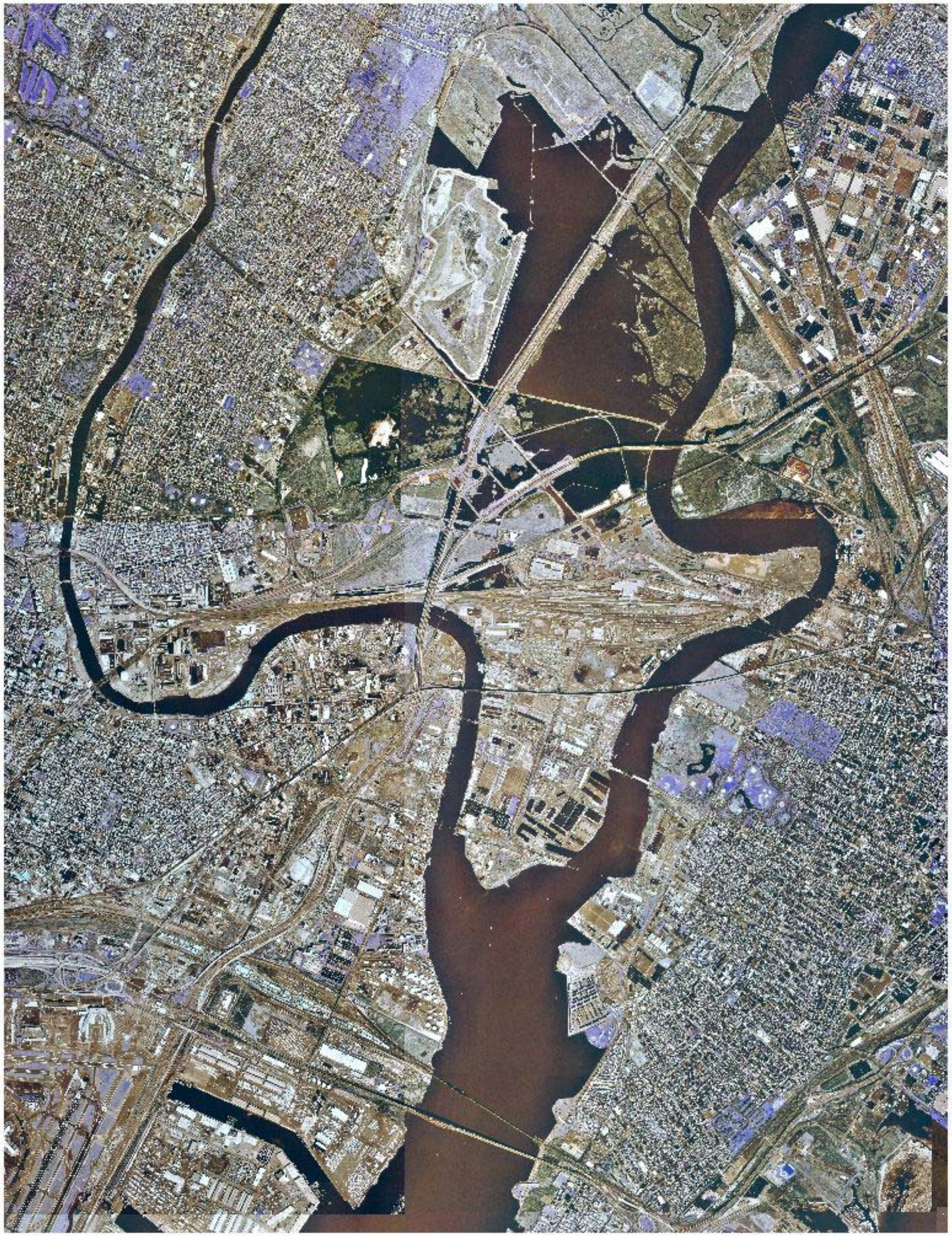

Lower Passaic River Landscape

Shoreline Habitat Classification Categories

Category	Description
Aquatic vegetation	Represents shoreline habitats composed of emergent wetland plant species such as *Spartina alterniflora* or *Phragmites*. Areas of aquatic vegetation often occur as narrow bands of vegetation near the top of the intertidal zone, typically with intertidal mudflat below.
Bulkhead	Consists of horizontal or vertical wood timbers, metal sheet pile, or large stone blocks constructed to form a vertical face perpendicular to the water surface
Riprap	Includes cobble to boulder-sized stone and/or concrete rubble placed along the shoreline on a sloped bank
Mixed vegetation	Represents areas with aquatic vegetation interspersed (laterally and/or longitudinally) with riprap and/or bulkhead. Areas of riprap shoreline with significant over-hanging riparian vegetation were also included as mixed vegetation to acknowledge the minor contribution to aquatic habitat provided by the adjacent riparian vegetation.

Typical Bulkhead

Bulkhead, Riprap, Outfalls

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Mixed Vegetation/Mudflat

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Shoreline Habitat Characterization for the PRSA — Point-No-Point Reach

Shoreline Habitat Type	Right Bank[a]		Left Bank[b]	
	Linear Feet	Percent of Total	Linear Feet	Percent of Total
Bulkhead	1,219	16%	4,994	63%
Riprap	4,128	54%	2,873	37%
Mixed vegetation[c]	883	12%	0	0%
Aquatic vegetation	1,407	18%	0	0%
Total shoreline (feet)	**7,637**		**7,867**	

Notes:

[a] Right bank facing downstream (e.g., western/southern shoreline).

[b] Left bank facing downstream (e.g., eastern/northern shoreline).

[c] Mixed vegetation refers to areas of aquatic/upland vegetation interspersed with riprap or bulkhead and areas of riprap shoreline with significant overhanging riparian vegetation.

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Shoreline Habitat Characterization for the PRSA — Harrison Reach

	Right Bank[a]		Left Bank[b]	
Shoreline Habitat Type	**Linear Feet**	**Percent of Total**	**Linear Feet**	**Percent of Total**
Bulkhead	4,524	39%	3,131	25%
Riprap	4,508	38%	4,037	32%
Mixed vegetation[c]	2,171	19%	3,409	27%
Aquatic vegetation	519	4%	1,917	15%
Total shoreline (feet)	**11,722**		**12,494**	

Notes:

[a] Right bank facing downstream (e.g., western/southern shoreline).

[b] Left bank facing downstream (e.g., eastern/northern shoreline).

[c] Mixed vegetation refers to areas of aquatic/upland vegetation interspersed with riprap or bulkhead and areas of riprap shoreline with significant overhanging riparian vegetation.

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Shoreline Habitat Characterization for the PRSA — Newark Reach

	Right Bank[a]		Left Bank[b]	
Shoreline Habitat Type	**Linear Feet**	**Percent of Total**	**Linear Feet**	**Percent of Total**
Bulkhead	6,860	81%	5,973	77%
Riprap	1,562	19%	1,796	23%
Mixed vegetation[c]	0	0%	0	0%
Aquatic vegetation	0	0%	0	0%
Total shoreline (feet)	**8,422**		**7,769**	

Notes:

[a] Right bank facing downstream (e.g., western/southern shoreline).

[b] Left bank facing downstream (e.g., eastern/northern shoreline).

[c] Mixed vegetation refers to areas of aquatic/upland vegetation interspersed with riprap or bulkhead and areas of riprap shoreline with significant overhanging riparian vegetation.

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Shoreline Habitat Characterization for the PRSA — Kearny Reach

	Right Bank[a]		Left Bank[b]	
Shoreline Habitat Type	**Linear Feet**	**Percent of Total**	**Linear Feet**	**Percent of Total**
Bulkhead	4,802	90%	3,214	62%
Riprap	526	10%	800	15%
Mixed vegetation[c]	0	0%	1,189	23%
Aquatic vegetation	0	0%	0	0%
Total shoreline (feet)	**5,328**		**5,203**	

Notes:

[a] Right bank facing downstream (e.g., western/southern shoreline).

[b] Left bank facing downstream (e.g., eastern/northern shoreline).

[c] Mixed vegetation refers to areas of aquatic/upland vegetation interspersed with riprap or bulkhead and areas of riprap shoreline with significant overhanging riparian vegetation.

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Shoreline Habitat Characterization for the PRSA ─ Arlington Reach

	Right Bank[a]		Left Bank[b]	
Shoreline Habitat Type	**Linear Feet**	**Percent of Total**	**Linear Feet**	**Percent of Total**
Bulkhead	573	89%	0	0%
Riprap	70	11%	30	4%
Mixed vegetation[c]	0	0%	655	96%
Aquatic vegetation	0	0%	0	0%
Total shoreline (feet)	**643**		**685**	

Notes:

[a] Right bank facing downstream (e.g., western/southern shoreline).

[b] Left bank facing downstream (e.g., eastern/northern shoreline).

[c] Mixed vegetation refers to areas of aquatic/upland vegetation interspersed with riprap or bulkhead and areas of riprap shoreline with significant overhanging riparian vegetation.

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Shoreline Habitat Characterization for the PRSA — Cumulative Total

	Right Bank[a]		Left Bank[b]		Total Shoreline	
Shoreline Habitat Type	**Linear Feet**	**Percent of Total**	**Linear Feet**	**Percent of Total**	**Linear Feet**	**Percent of Total**
Bulkhead	17,978	53%	17,312	51%	35,290	52%
Riprap	10,794	32%	9,536	28%	20,330	30%
Mixed vegetation[c]	3,054	9%	5,253	15%	8,307	12%
Aquatic vegetation	1,926	6%	1,917	6%	3,843	6%
Total shoreline (feet)	**33,752**		**34,018**		**67,770**	

Notes:

[a] Right bank facing downstream (e.g., western/southern shoreline).

[b] Left bank facing downstream (e.g., eastern/northern shoreline).

[c] Mixed vegetation refers to areas of aquatic/upland vegetation interspersed with riprap or bulkhead and areas of riprap shoreline with significant overhanging riparian vegetation.

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Key Habitats in PRSA

- Intertidal mudflats (although very degraded)
- Frank's Creek confluence area
  - Limited *Spartina alterniflora* stand
- Lawyer's Creek confluence area
  - Mixed *Phragmites australis* and *Spartina* stand

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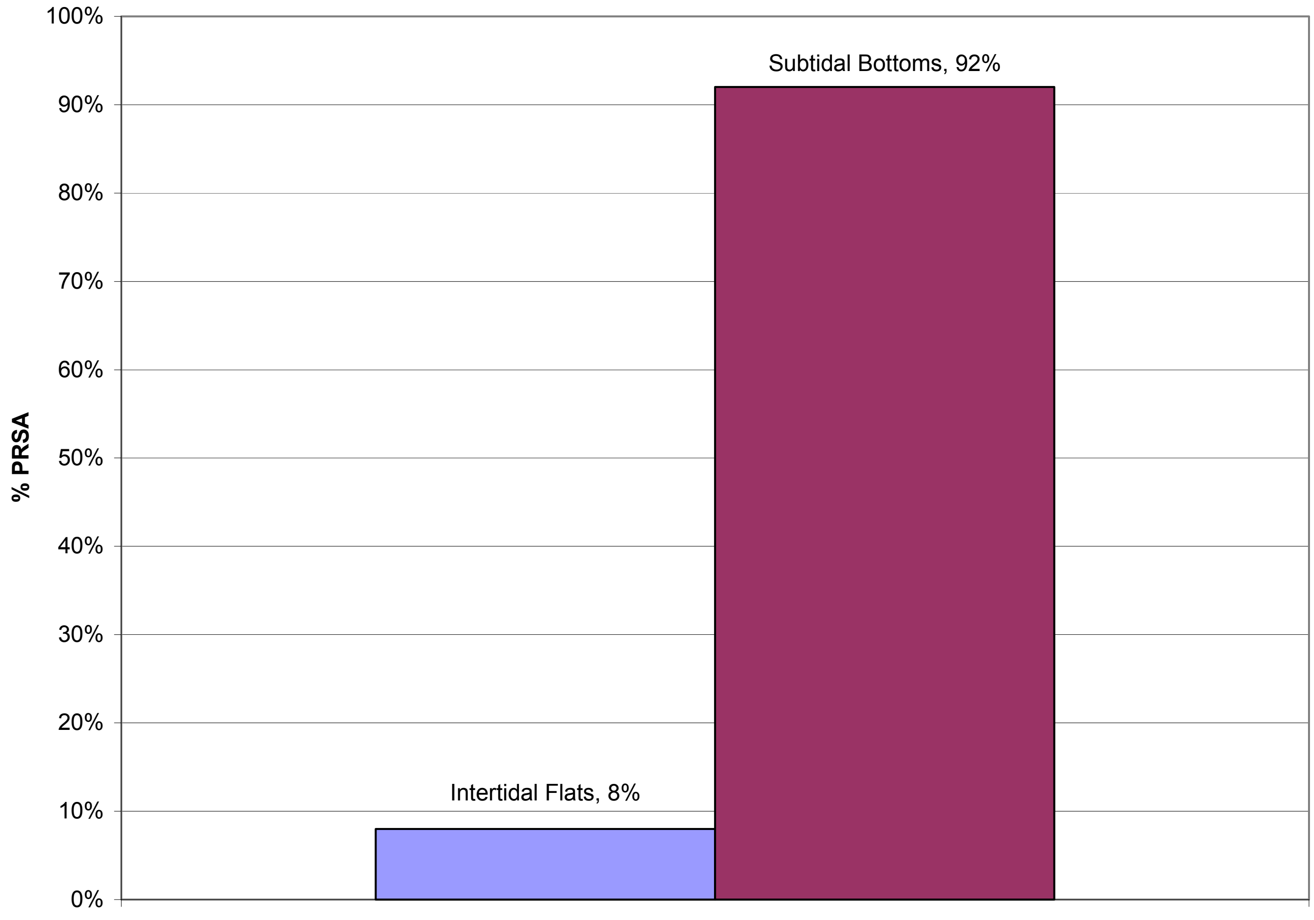
Typical Mudflat Area

Typical Mudflat Area

River Bottom Habitat



Estimates of Historical Wetland Losses in the Newark Bay Estuary

Year	Acres	Cumulative Percent Loss
Pre-1816[a]	24,466	--
1870	18,166	26
1905	15,790	36
1932	11,968	51
1940	11,180	54
1954	8,738	64
1966	5,574	77
1976	3,570	85
1989	3,058	88
1997	2,921	88

[a] Based on sum of mapped wetlands in 1870 and reported wetlands losses for period of 1816 through 1867.

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Estimated Losses of Historical Rivers, Creeks, and Tributaries in the Lower Passaic River and Newark Bay

River/Creek	Estimated Length Lost (mi)
Bound Creek and Tributaries	18.1
Maple Island Creek and Tributaries	13.2
First River and Tributaries	6.0
Unnamed Passaic Tributary Creeks	0.7
Kearny Marsh Tributaries	1.2
Great Meadow Brook and Tributaries	6.3
Oyster Creek and Tributaries	2.3
Upper Newark Bay Tributaries	10.9
Other Newark Bay Tributaries	20.2
Total Lost	76.6

Lawyer's Creek Confluence with PRSA

Frank's Creek Confluence with PRSA

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Conclusions

- Wetlands limited primarily to degraded intertidal mudflats and fringe vegetation
- Majority of shoreline (>80%) consists of bulkhead and riprap = very little habitat value
- Less than 10% of the shoreline area contains aquatic/wetlands vegetation

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Benthic Invertebrate Community Characterization

Objectives

- Compare structure and composition of benthic invertebrate community in PRSA to Mullica River reference area
- Contrast differences between stations in PRSA
- Conduct sediment quality triad (SQT) assessment

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Methods

- 15 PRSA stations/3 reference area stations
- Fall 1999 and Spring 2000 sampling
- 3 replicate samples per station (middle sampling grid)
- Modified Van Veen sampler ─ biologically active zone (about 0- to 6-inch depth)
- Identification to lowest practicable taxon
- Assessment of community structure/composition metrics

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Results

- High inter-station variability in both PRSA and reference area
- Seasonal variability
- Many “impacted” stations in PRSA

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Listing of Species Found in the PRSA and Reference Area

Taxon		Fall 1999 RA	Fall 1999 PRSA	Spring 2000 RA	Spring 2000 PRSA
Amphipoda					
	Ampelisca sp.	X		X	
	Corophium lacustre	X			
	Gammarus mucronatus			X	X
	Gammarus sp.	X	X	X	X
	Leptocheirus plumulosus	X		X	X
	Melita nitida			X	
Bivalvia					
	Macoma sp.	X	X	X	X
	Mya arenaria				X
Decapoda					
	Callinectes sapidus		X		
	Crangon septemspinosa		X		
	Palaemonetes pugio	X			
	Palaemonetes sp.			X	
Diptera					
	Ceratopogon sp.		X		X
	Procladius sp.		X		X
	Psychoda sp.				X
	Thienemannimyia group				X
Isopoda					
	Chiridotea coeca		X		
	Cyathura polita	X	X	X	X

Taxon		Fall 1999 RA	Fall 1999 PRSA	Spring 2000 RA	Spring 2000 PRSA
Mysidacea					
	Neomysis americana				X
Nemertinia					
	Cerebratulus lacteus	X	X	X	X
Oligochaeta					
	Naididae		X		
	Tubificidae				
	poss. Enchytraeus sp.		X		X
	Ilyodrilus templetoni				X
	Limnodrilus sp.		X		X
	Quistadrilus multisetosus		X		
	imm. Tub. w/ hair chaetae		X		X
	Tubificoides heterochaetus				X
Polychaeta					
	Eteone heteropoda			X	X
	Glycinde solitaria	X		X	X
	Heteromastus filiformis	X	X	X	X
	Laeonereis culveri	X	X		X
	Leitoscoloplos fragilis	X		X	X
	Leitoscoloplos robustus	X			
	Maldanopsiselongata	X			
	Marenzelleria viridis	X	X	X	X
	Neanthese sp.			X	X
	Spio sp.	X			
	Streptoblospio benedicti				X
Rhynchocoela					
	Lineidea			X	

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Description of Benthic Invertebrate Community Structure Metrics

Metric	Description
Number of individuals	The total number of organisms in a sample. Large numbers of individuals in a particular sample may indicate that the sample is dominated or co-dominated by opportunistic species (e.g., tubificid oligochaetes or other tolerant taxa).
Number of taxa	The total number of species (or taxa) in a sample. Low numbers of taxa indicate potentially stressed areas.
Shannon-Wiener Diversity H´	Commonly known as Shannon's H´. It is a measurement of species diversity that has been widely used throughout the biological literature. In general, low diversity values (e.g., 1.0 or less) may indicate a potentially more stressful environment than communities with higher diversity values (e.g., 3.0 or more).
Pielou's Evenness	The minimal level of difference between observed species abundances and those from a hypothetical aggregation of species that have maximum diversity. Higher evenness values suggest a greater "equitable distribution of individuals" among taxa whereas low values suggest that this distribution is less apparent.
Brillouin's Diversity	A more refined version of Shannon's H´ that is an estimate of diversity that is free of sampling error.
Swartz's Dominance Index	This index is defined as the minimum number of taxa that makes up 75 percent of the sample abundance. The greater number of taxa that comprise 75% of the sample, the greater the diversity in that sample.
Virginia Province Index of Biotic Integrity (IBI)	The Virginia IBI uses a variety of benthic metrics that consider functional and structural elements of the benthic invertebrate community. Values of IBI calculated at "impacted" sites that are within the range of values calculated in reference areas are considered similar.

Description of Benthic Invertebrate Community Composition Metrics

Metric	Description
Percent abundance of crustacea	In general, crustacea (particularly amphipods) are largely recognized as taxa that are sensitive to pollutants in aquatic environments. Their presence in samples (expressed as a percent of the total number of species) is considered a good indicator of non-toxic conditions and favorable habitat in the substrate.
Percent pollution-tolerant organisms	Represented mainly by opportunistic oligochaetes that will typically dominate (or co-dominate) samples in stressed aquatic environments. The sum of individuals in these taxa are calculated and expressed as a relative contribution (%) to the total number of individuals in the sample.

Benthic Invertebrate Community Structure Metrics

Station	Number of Individuals (ind/m^2)	Number of Taxa	Shannon-Wiener Diversity (H')	Pielou's Evenness (J)	Brillouin Diversity (H)	Swartz's Dominance Index	Virginian Province Biotic Index
PRSA							
1	2,855	4	0.40	0.29	0.39	1	-1.6
2	1,072	4	0.64	0.46	0.63	1	-0.84
3	1,261	7	1.0	0.51	0.98	2	-0.72
4	1,145	3	0.23	0.21	0.22	1	-1.1
5	1,507	4	0.50	0.36	0.50	1	-0.62
6	725	6	0.76	0.43	0.75	1	0.86
7	681	5	0.60	0.38	0.59	1	-0.24
8	754	5	0.79	0.49	0.78	1	-0.042
9	1,290	4	0.71	0.51	0.71	1	-6.8
10	1,087	2	0.069	0.10	0.067	1	-7.0
11	11,913	3	0.71	0.64	0.71	2	-66
12	9,971	2	0.29	0.42	0.29	1	-56
13	217	6	1.6	0.90	1.6	4	0.090
14	1,493	2	0.36	0.52	0.36	1	-9.6
15	1,623	4	0.71	0.51	0.70	2	-9.3
Reference Area							
21	841	8	1.5	0.73	1.5	3	1.7
22	1,609	8	0.73	0.35	0.72	1	1.7
23	101	3	0.95	0.87	0.91	2	-0.73

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Benthic Invertebrate Community Composition Metrics

Station	Percent Abundance of Crustacea	Percent Pollution-Tolerant Organisms
PRSA		
1	8%	2%
2	20%	0%
3	8%	14%
4	4%	0%
5	3%	0%
6	16%	0%
7	4%	2%
8	17%	6%
9	0%	93%
10	0%	99%
11	0%	100%
12	0%	100%
13	27%	13%
14	0%	100%
15	0%	99%
Reference Area		
21	72%	0%
22	94%	0%
23	57%	0%

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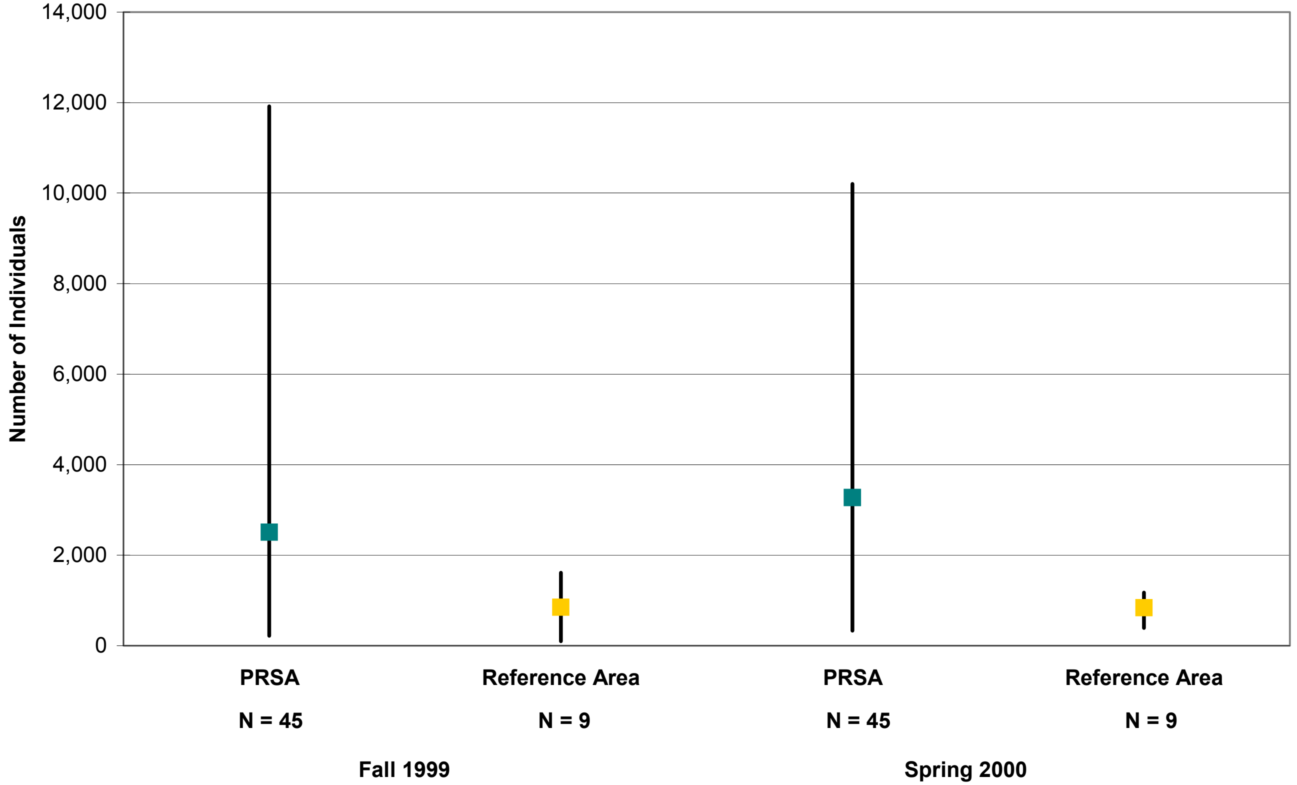
Benthic Invertebrate Community Assessment: Number of Individuals



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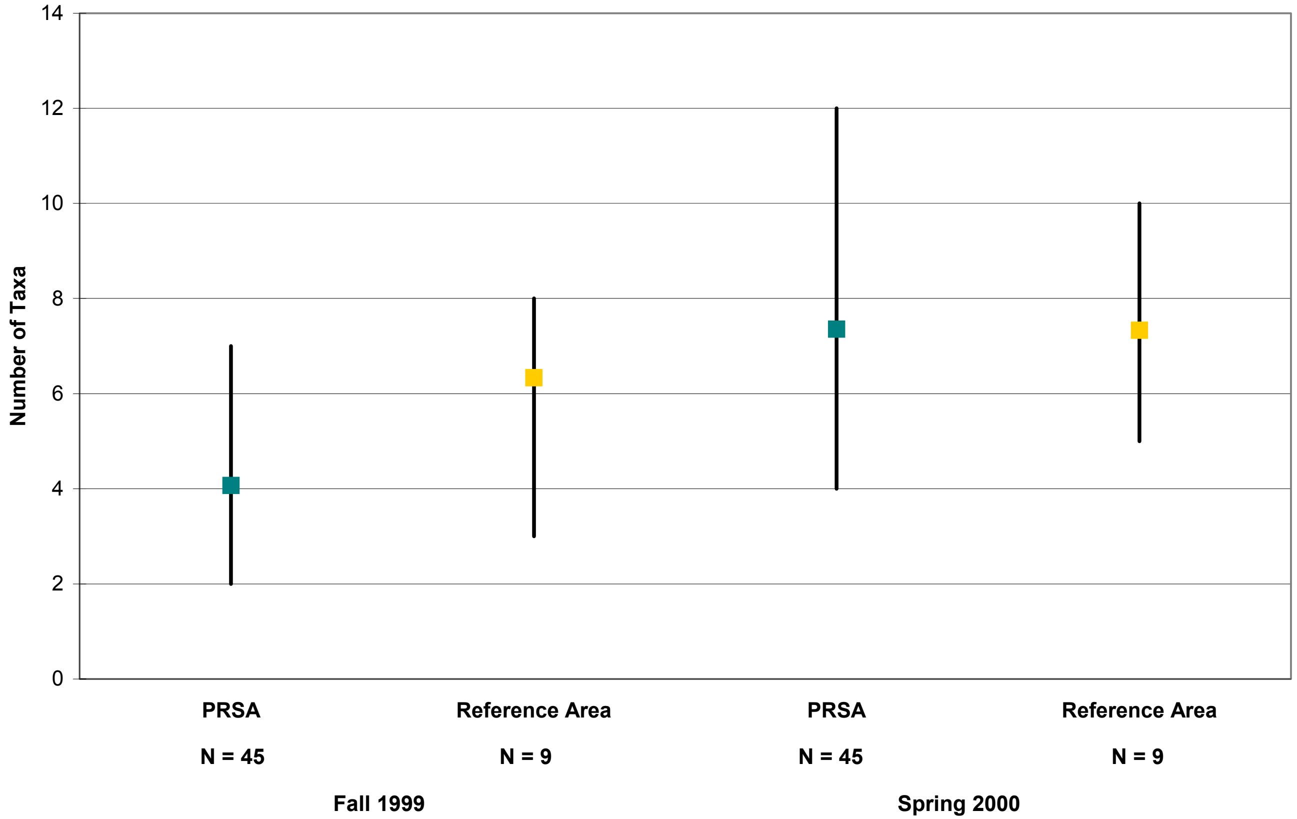
Benthic Invertebrate Community Assessment: Number of Taxa



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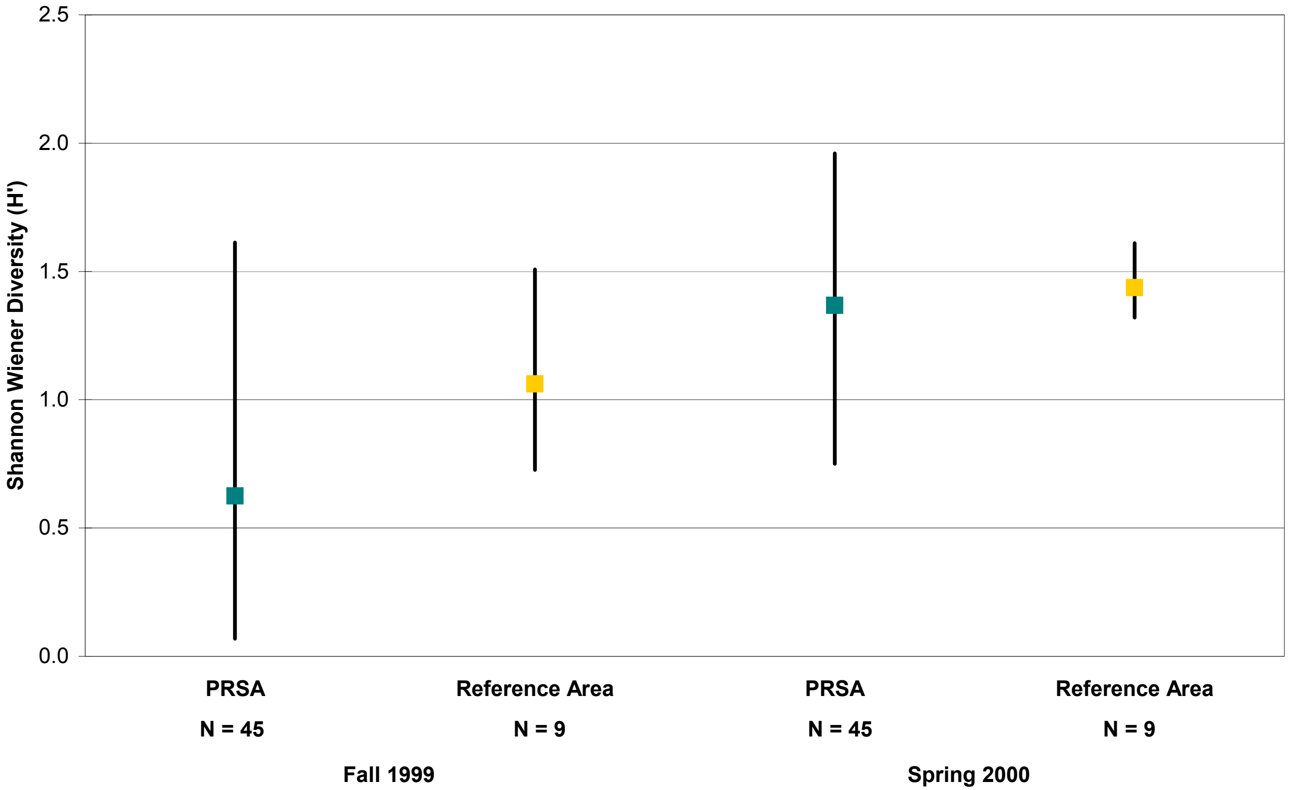
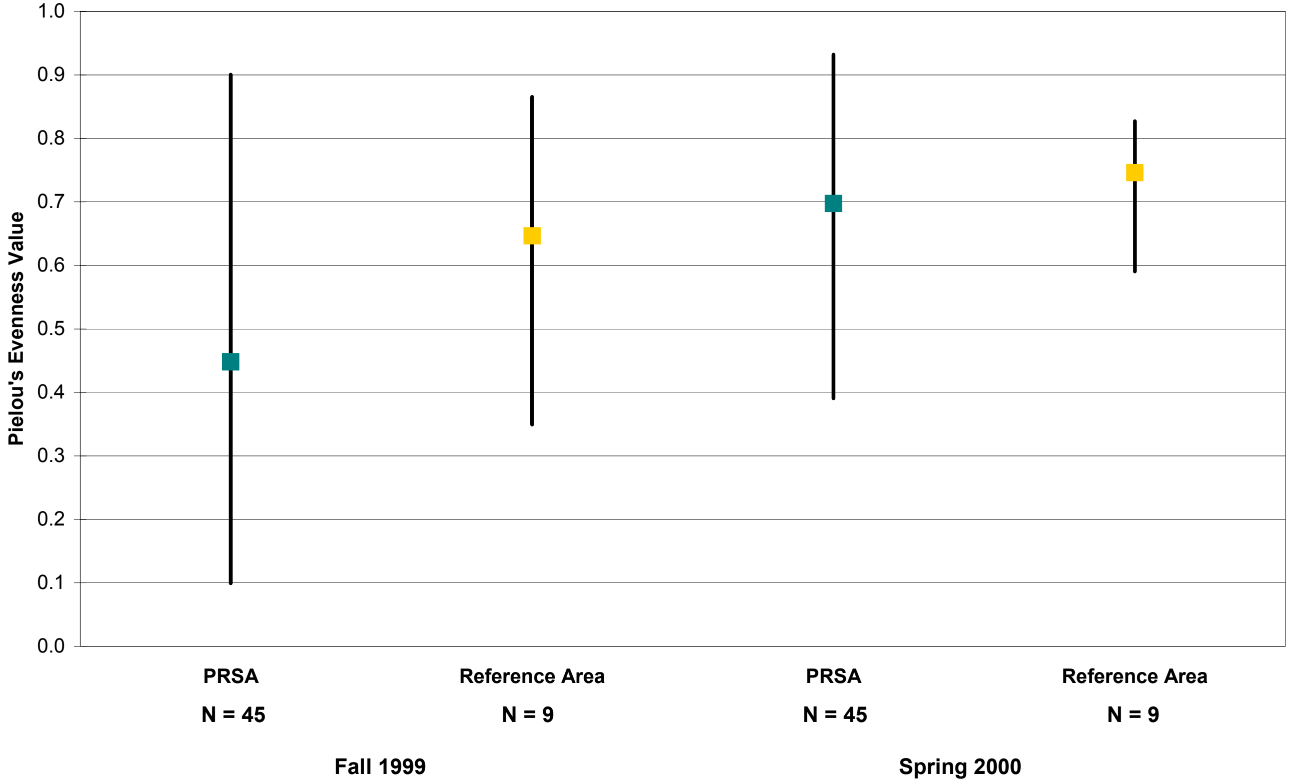
Benthic Invertebrate Community Assessment: Shannon-Wiener Diversity (H´)



Benthic Invertebrate Community Assessment: Pielou's Evenness



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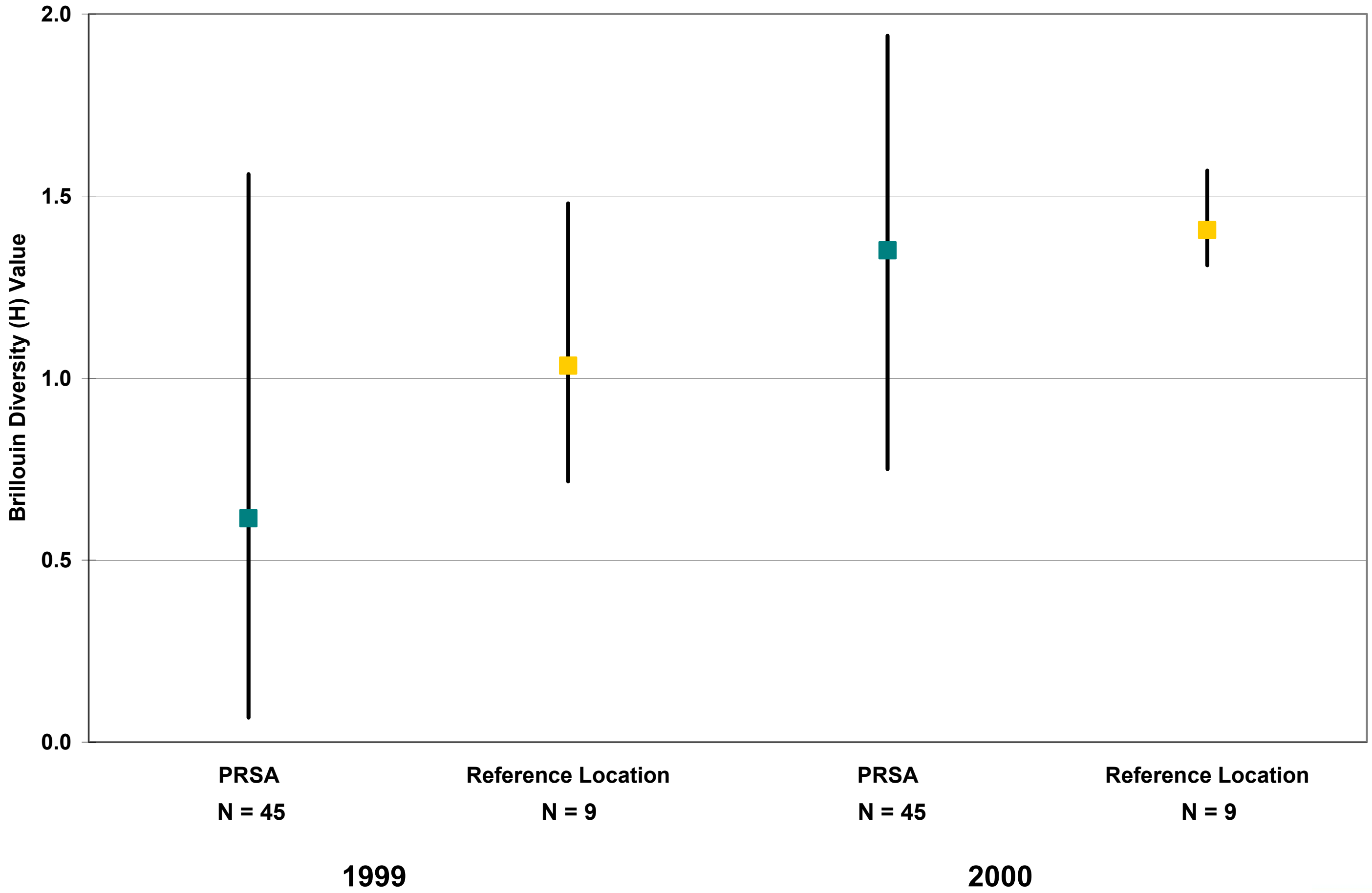
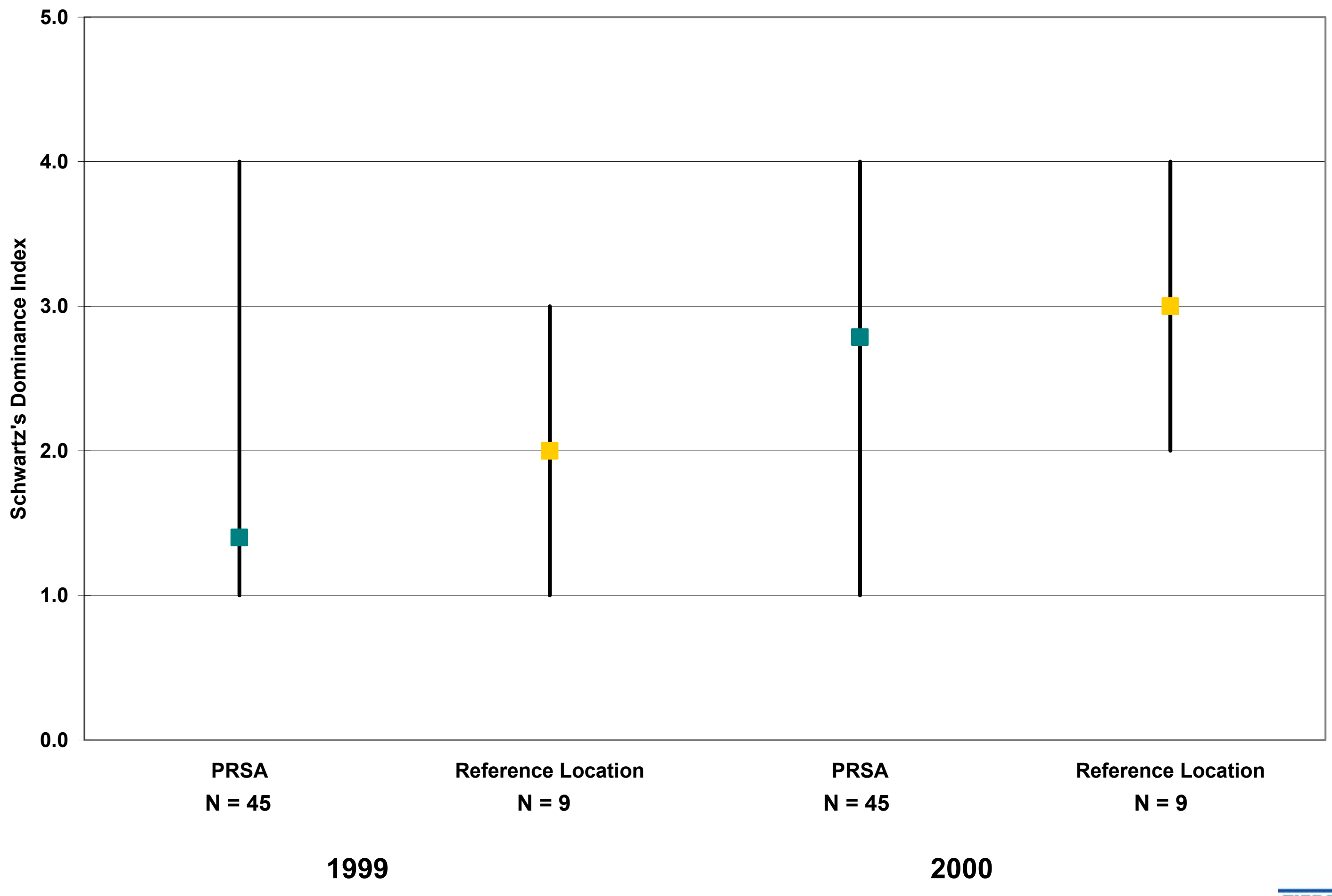
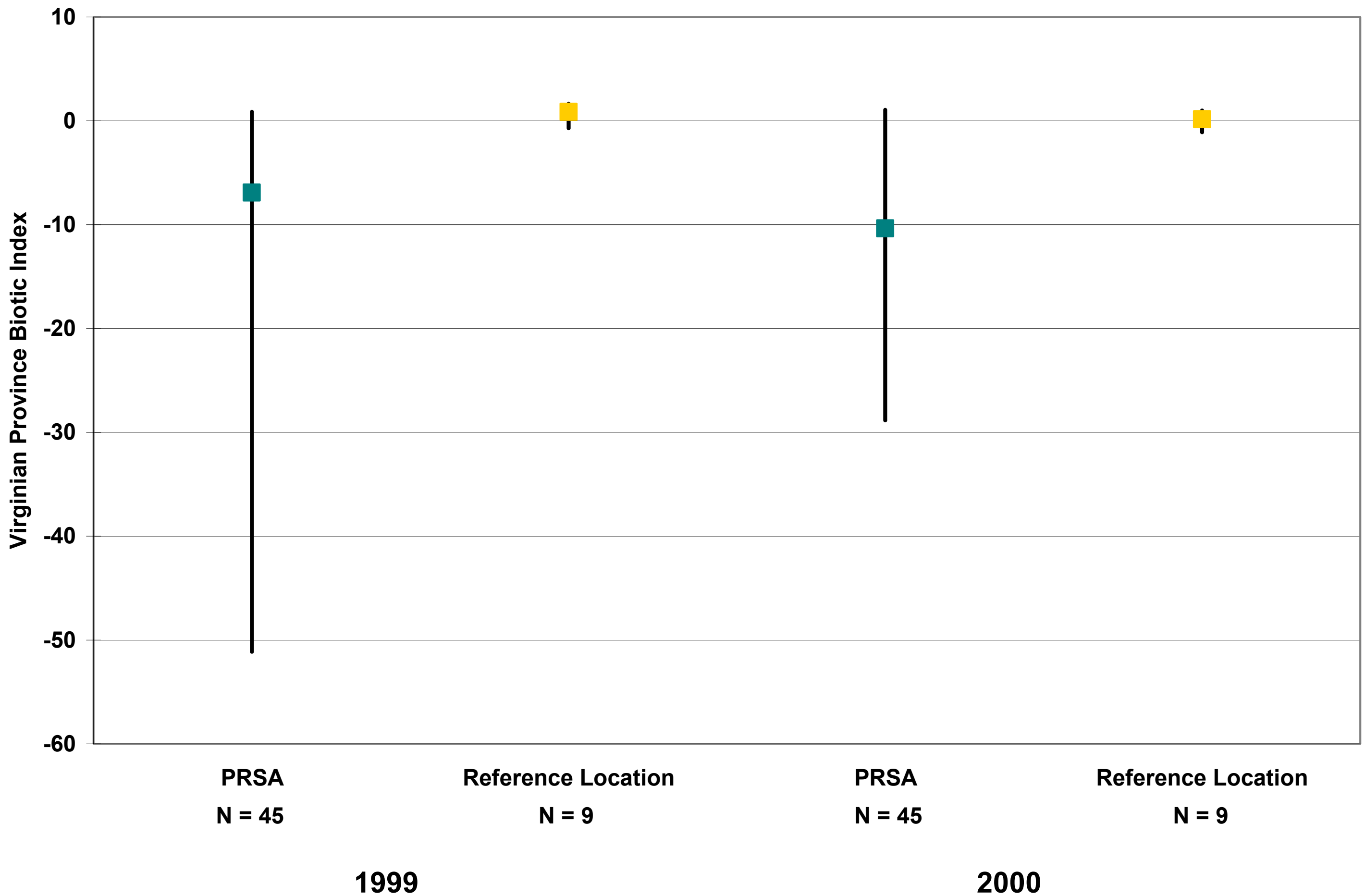
Brillouin Diversity (H)



Swartz's Dominance Index



Virginian Province Biotic Index



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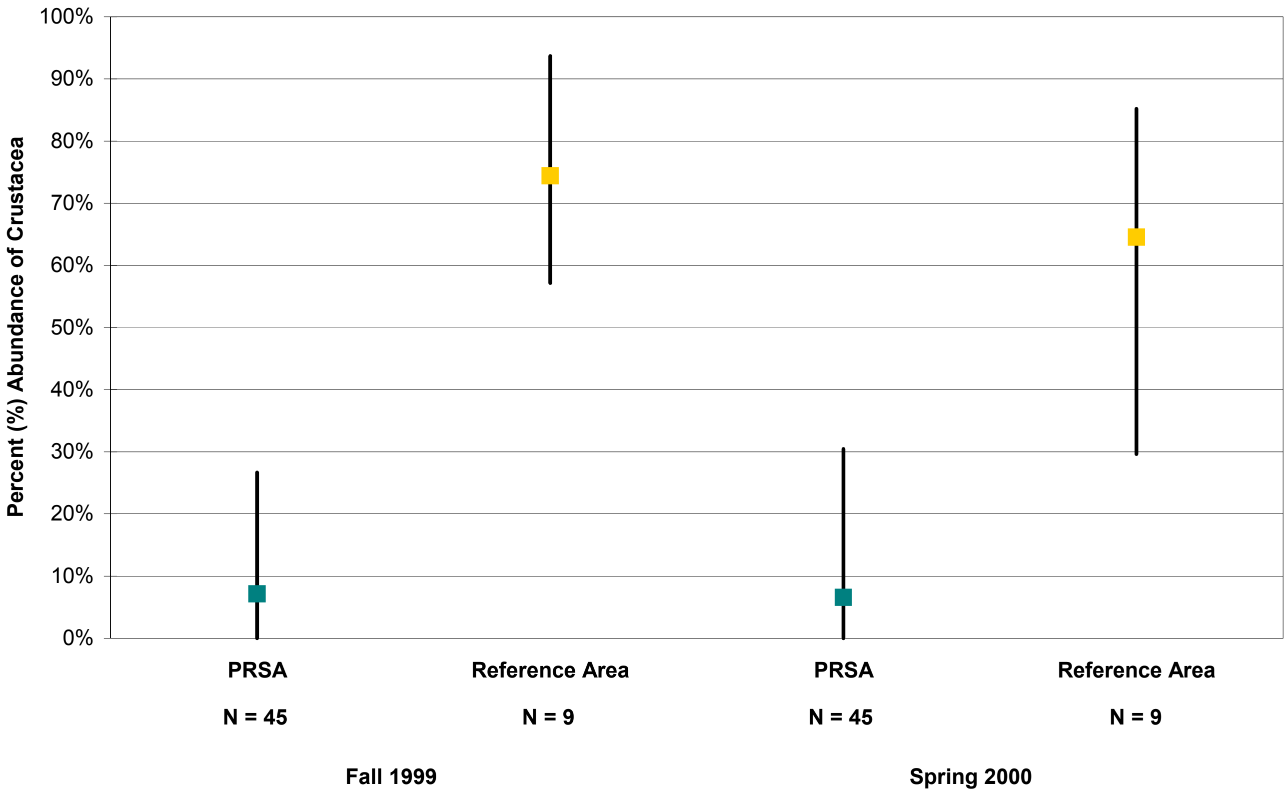
Benthic Invertebrate Community Assessment: Percent Abundance of Crustacea



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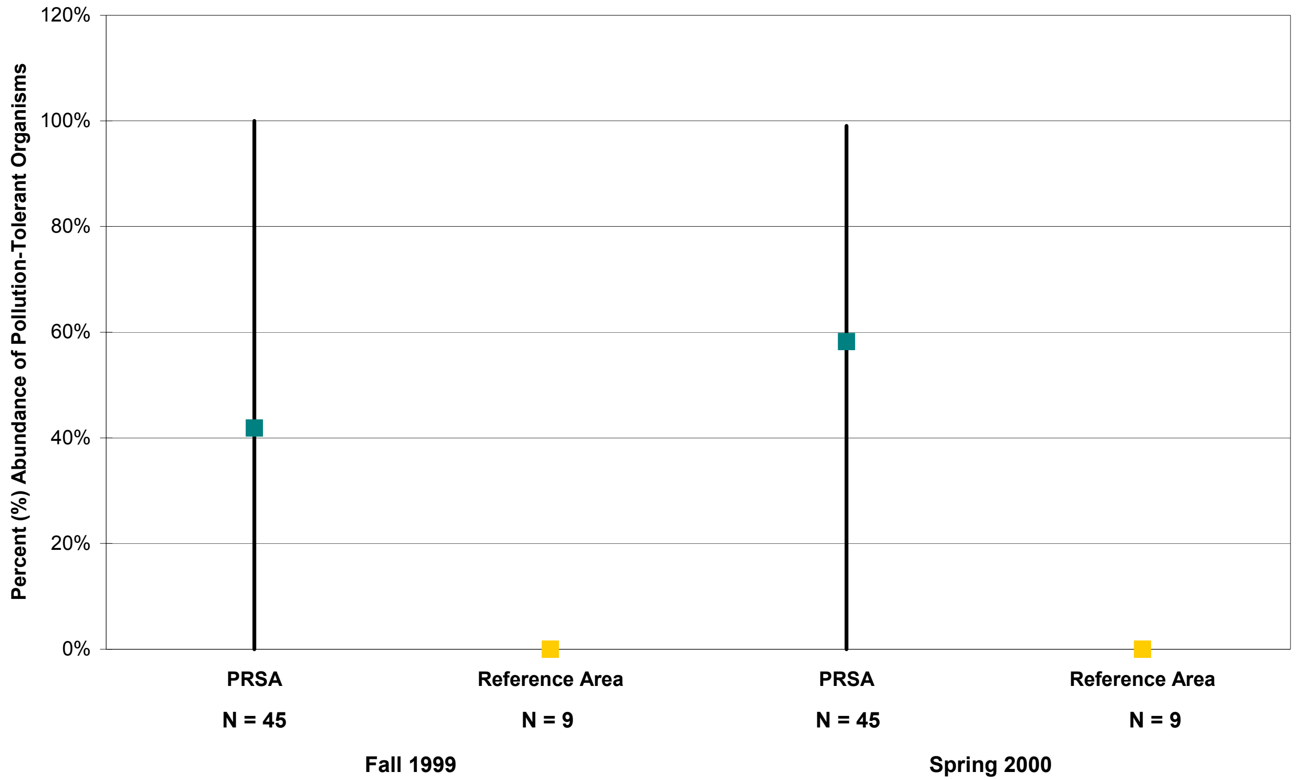
Benthic Invertebrate Community Assessment: Percent Abundance of Pollution-Tolerant Organisms



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Classification System for PRSA Benthic Invertebrate Communities

	Number of Individuals	Number of Taxa	Shannon's H′	Pielou's Eveness	Brillouin's H	Swartz Dominance Index	Virginian Province Index of Biotic Integrity	Abundance of Crustacea	Abundance of Pollution-tolerant Taxa
Poor	above Reference Area range (>1,609/m^2)	below Reference Area range (<3)	below Reference Area range (<0.73)	below Reference Area range (<0.73)	below Reference Area range (<0.72)	below Reference Area range (<1)	below Reference Area range (<-0.73)	below Reference Area range (<57%)	above Reference Area range (>0%)
Good	within Reference Area range (101 - 1,609/m^2)	within Reference Area range (3 - 8)	within Reference Area range (0.73 - 1.5)	within Reference Area range (0.73 - 0.87)	within Reference Area range (0.72 - 1.5)	within Reference Area range (1 -3)	within Reference Area range (-0.73 - 1.7)	within Reference Area range (57 - 94%)	within Reference Area range (0%)
Excellent	below Reference Area range (<101/m^2)	above Reference Area range (>8)	above Reference Area range (>1.5)	above Reference Area range (>0.87)	above Reference Area range (>1.5)	above Reference Area range (>3)	above Reference Area range (>1.7)	above Reference Area range (> 94%)	NA

Note:
- NA - Not applicable

Qualitative Ranks for Each PRSA Station Compared to Reference Area

Metric	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of Individuals [1]	**poor**	good	good	good	good	good	good	good	good	good	**poor**	**poor**	good	good	**poor**
No. of Taxa	good	good	good	good	good	good	good	good	good	**poor**	good	**poor**	good	**poor**	good
Abundance of Crustacea	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**
Abundance of Tollerant Taxa [1]	**poor**	good	**poor**	good	good	good	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**
Pielou's Eveness	**poor**	good	good	**poor**	good	good	good	good	good	**poor**	good	good	***excellent***	good	good
Shannon's H'	**poor**	**poor**	good	**poor**	**poor**	good	**poor**	good	**poor**	**poor**	**poor**	**poor**	***excellent***	**poor**	**poor**
Virginia IBI	**poor**	**poor**	good	**poor**	good	good	good	good	**poor**	**poor**	**poor**	**poor**	good	**poor**	**poor**
Brillouin's H	**poor**	**poor**	good	**poor**	**poor**	good	**poor**	good	**poor**	**poor**	**poor**	**poor**	***excellent***	**poor**	**poor**
Swartz Dominance Index	good	good	good	good	good	good	good	good	good	good	good	good	***excellent***	good	good

Note:

[1] For the number of individuals and abundance of tolerant taxa metrics, the following ranks were assigned to each PRSA and Reference Area comparison: 1) above reference range = poor; b) within reference range = good; c) below reference range = excellent. For the remaining metrics, the following ranks were assigned for each PRSA/Reference Area comparison: a) above reference area = excellent; b) within reference area = good; c) below reference area = poor

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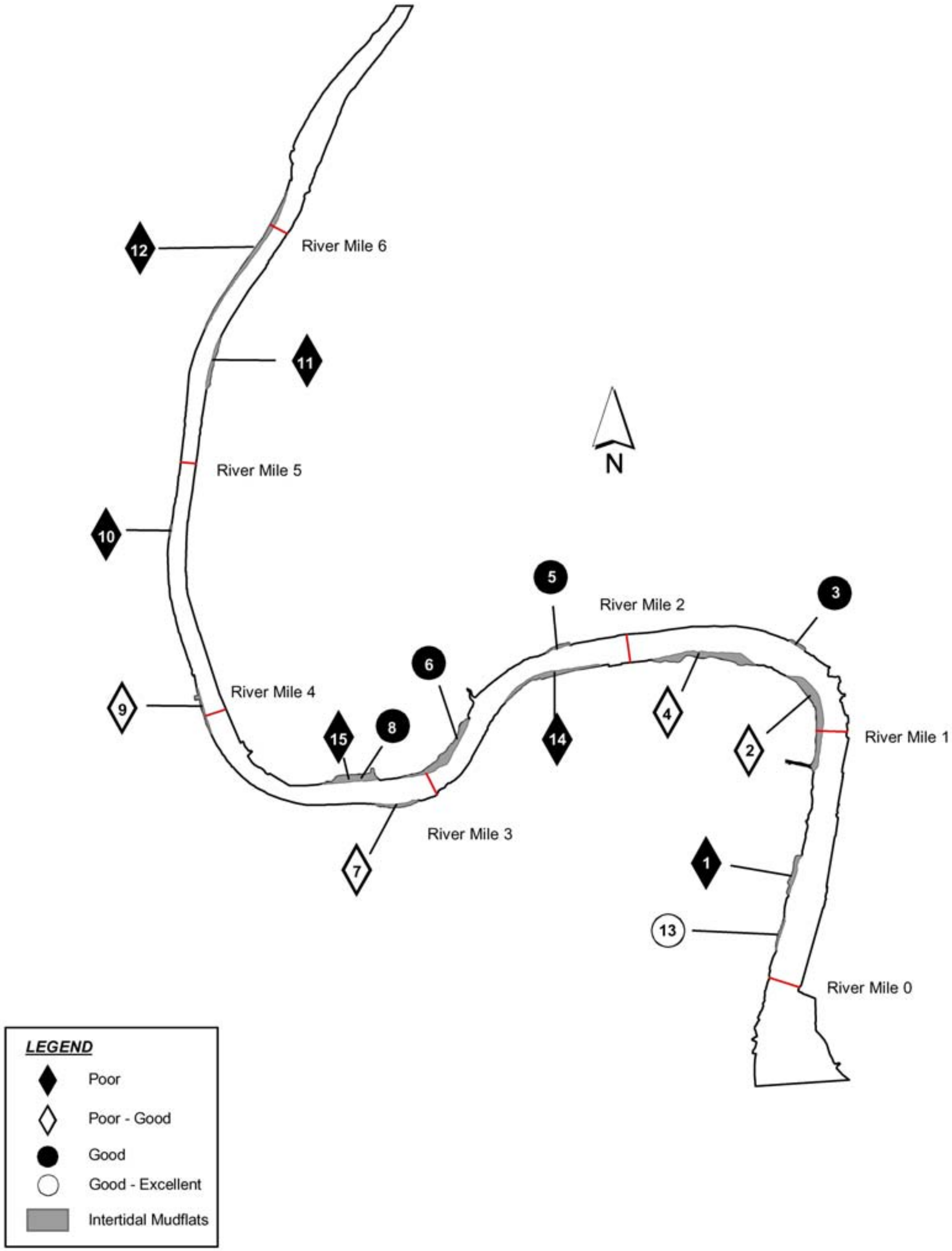
Benthic Invertebrate Community Condition in the PRSA



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Conclusions

- Benthic invertebrate communities in PRSA are different than those in the RA
- PRSA has high number of pollution-tolerant taxa, low number of crustaceans (pollution-sensitive) = chemical impacts
- “Quality” of benthic invertebrate community varies between PRSA stations – generally poor relative to RA

Fish Community Characterization

Objectives

- Characterize fish community of PRSA semi-quantitatively on a seasonal basis (Late Summer/Early Fall 1999, Spring 2000)
- Use surveys to confirm/select representative species for contaminant tissue sampling program
- Conduct qualitative pathology investigation on fish not collected for tissue samples

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Methods

- Three target sampling areas/stations in PRSA – lower, middle, and upper river
- Multiple gear types – gill nets, eel traps, minnow traps, crab traps
- Intensive fishing effort in Late Summer/ Early Fall 1999 (herein referred to as Fall 1999) and Spring 2000 – driven by tissue targets

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Methods (cont.)

- Length, weight, and pathology information collected for several species
- Minnow traps set at 15 PRSA stations to collect mummichog tissue samples
- Abundance, dominance, and catch-per-unit-effort (CPUE) calculated
- No reference area for fish community investigation

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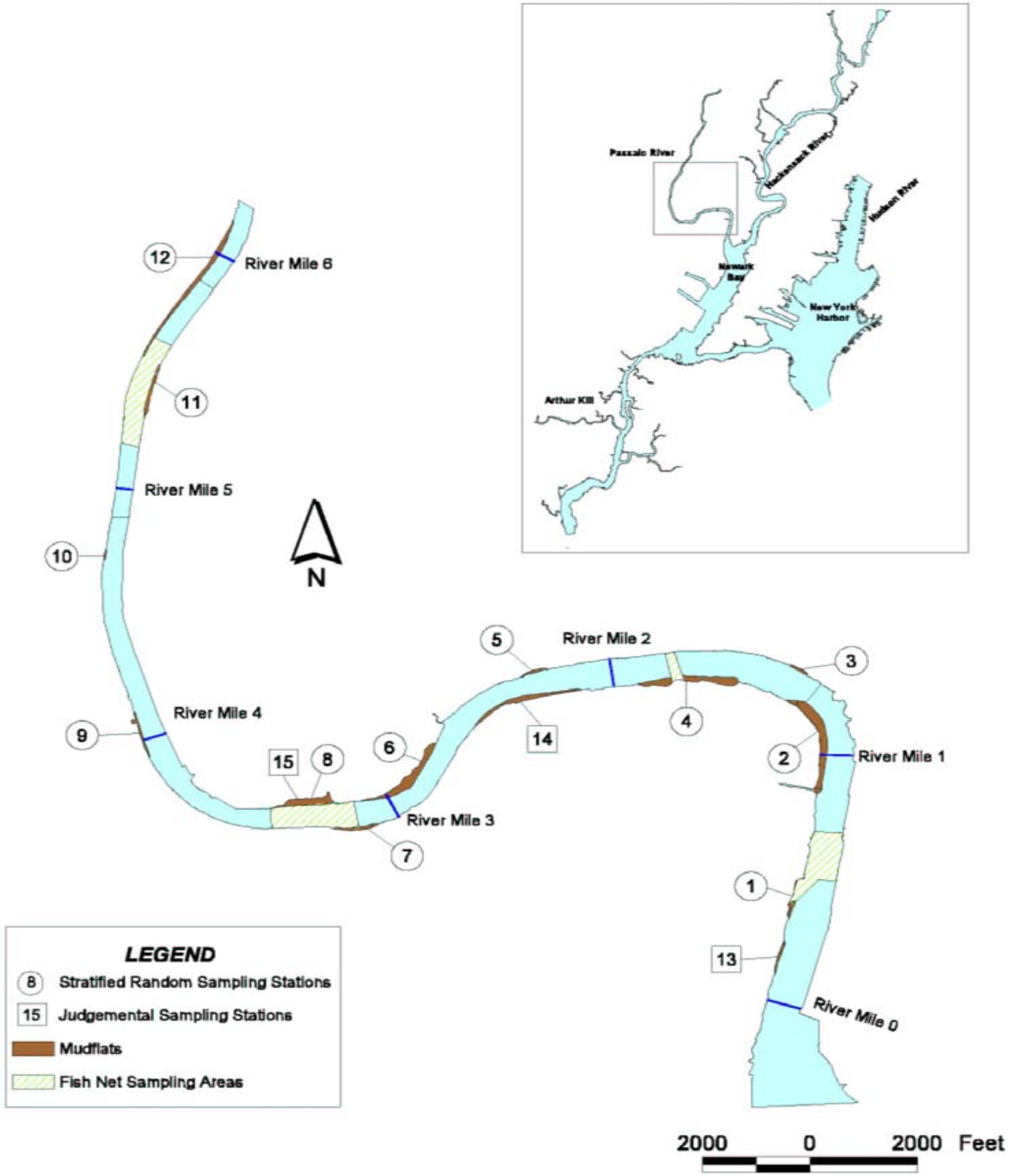

Figure 1. Passaic River Study Area Fish Sampling Stations

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List of Species Caught in PRSA – Fall 1999 and Spring 2000

Common Name	Scientific Name	Fish Caught	
		Fall 1999	Spring 2000
American eel	*Anguilla rostrata*		X
Atlantic menhaden	*Brevoortia tyrannus*	X	X
Atlantic silverside	*Menidia menidia*	X	
Blueback herring	*Alosa aestivalis*	X	X
Bluefish	*Pomatomus saltatrix*	X	
Bluegill	*Lepomis macrochirus*	X	
Brown bullhead	*Ameiurus nebulosus*		X
Channel catfish	*Ictalurus punctatus*	X	
Common carp	*Cyprinus carpio*		X
Gizzard shad	*Dorosoma cepedianum*	X	X
Green sunfish	*Lepomis cyanellus*	X	
Inland silverside	*Menidia beryllina*	X	
Largemouth bass	*Micropterus salmoides*	X	
Mummichog	*Fundulus heteroclitus*	X	X
Redear sunfish	*Lepomis microlophus*	X	
Spotted hake	*Urophycis regio*		X
Striped bass	*Morone saxatilis*	X	X
Striped killifish	*Fundulus majalis*	X	
Summer flounder	*Paralichthys dentatus*	X	
Weakfish	*Cynoscion regalis*	X	
White catfish	*Ameiurus catus*		X
White perch	*Morone americana*	X	X
White sucker	*Catastomus commersoni*		X

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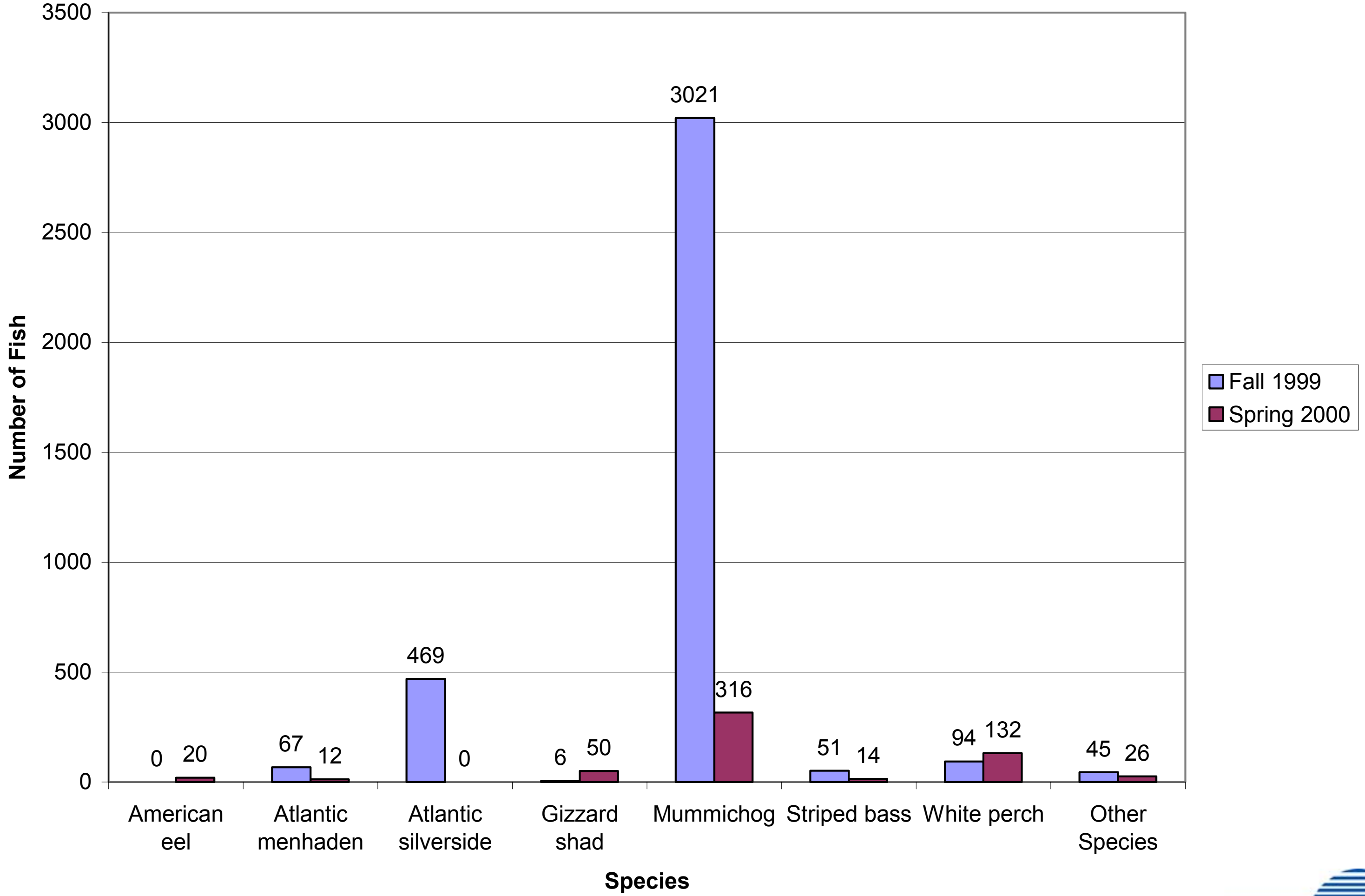
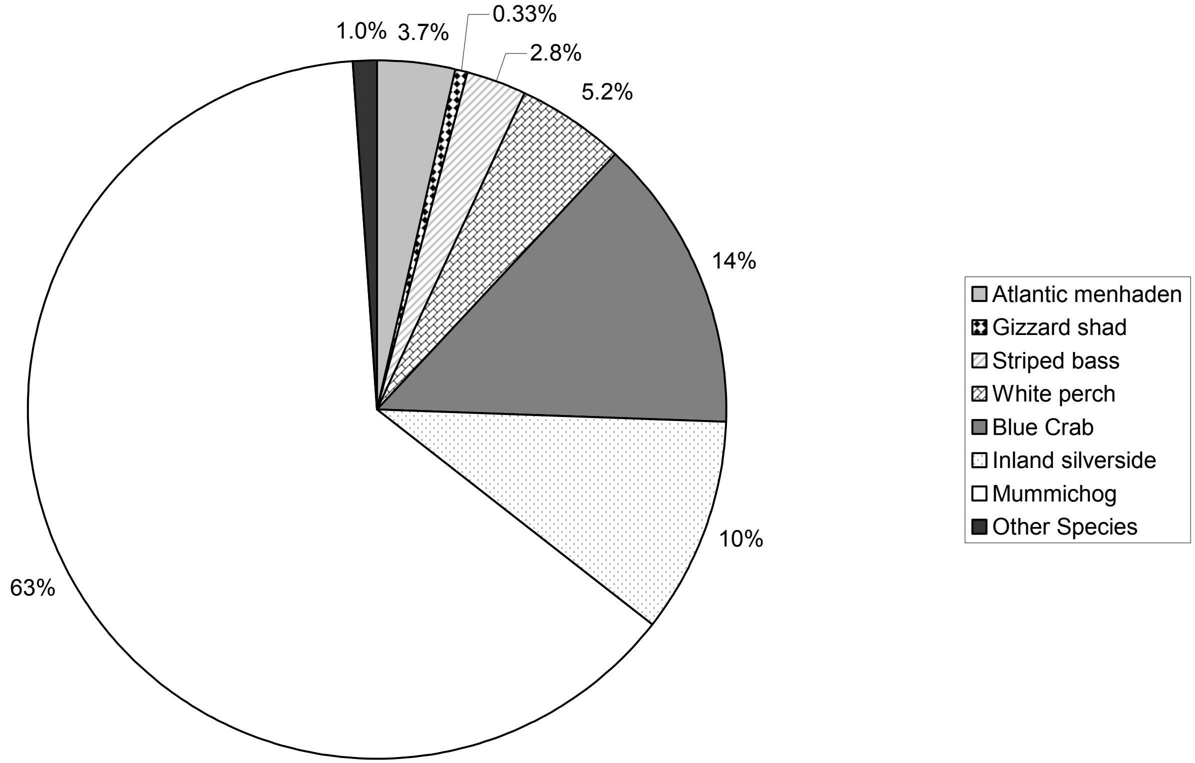
Number of Fish Caught in the PRSA



Percent CPUE Dominance of Fish Caught in the PRSA — Fall 1999



"Other Species" category includes blueback herring, bluefish, bluegill, brown bullhead, channel catfish, common carp, green sunfish, largemouth bass, redear sunfish, spotted hake, striped killifish, summer flounder, weakfish, white catfish, and white sucker.

Excludes incidental catch for each gear types (e.g., silversides in gill nets).

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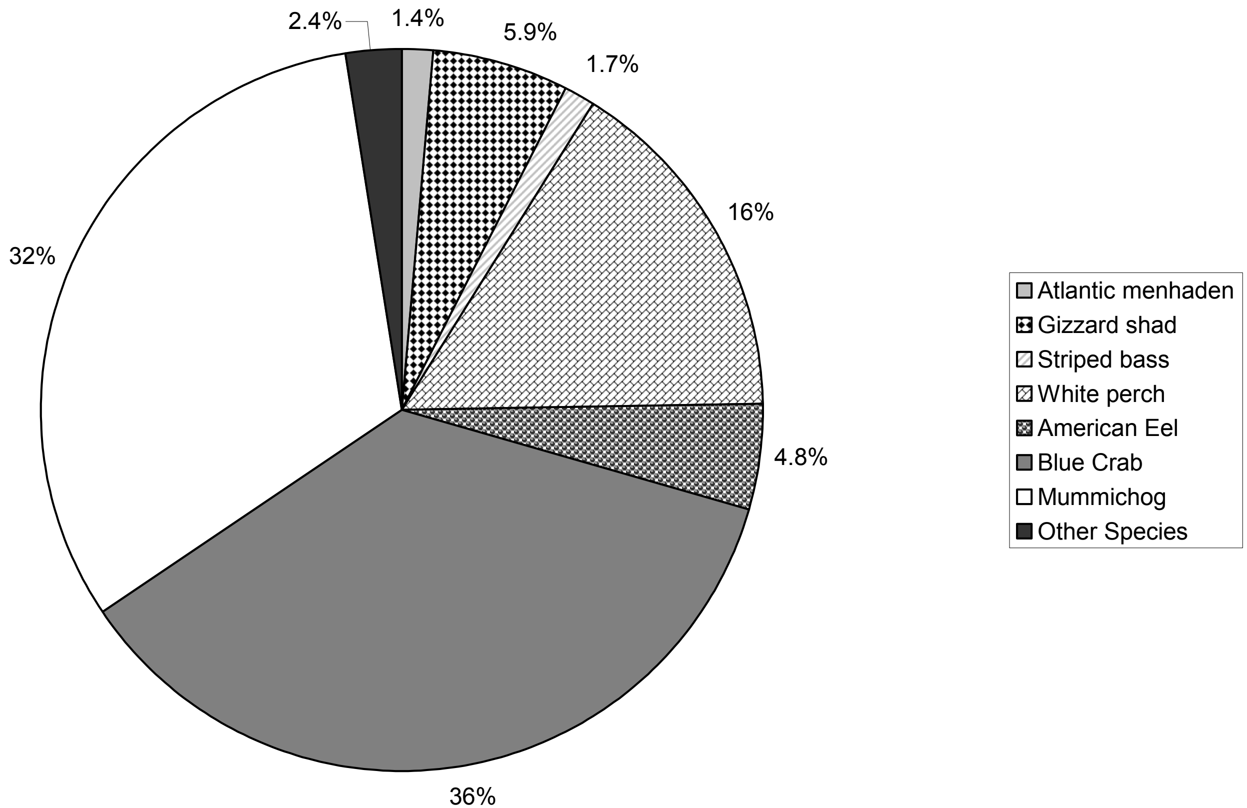
Percent CPUE Dominance of Fish Caught in the PRSA – Spring 2000



"Other Species" category includes blueback herring, bluefish, bluegill, brown bullhead, channel catfish, common carp, green sunfish, largemouth bass, redear sunfish, spotted hake, striped killifish, summer flounder, weakfish, white catfish, and white sucker.

Excludes incidental catch for each gear types (e.g., silversides in gill nets).

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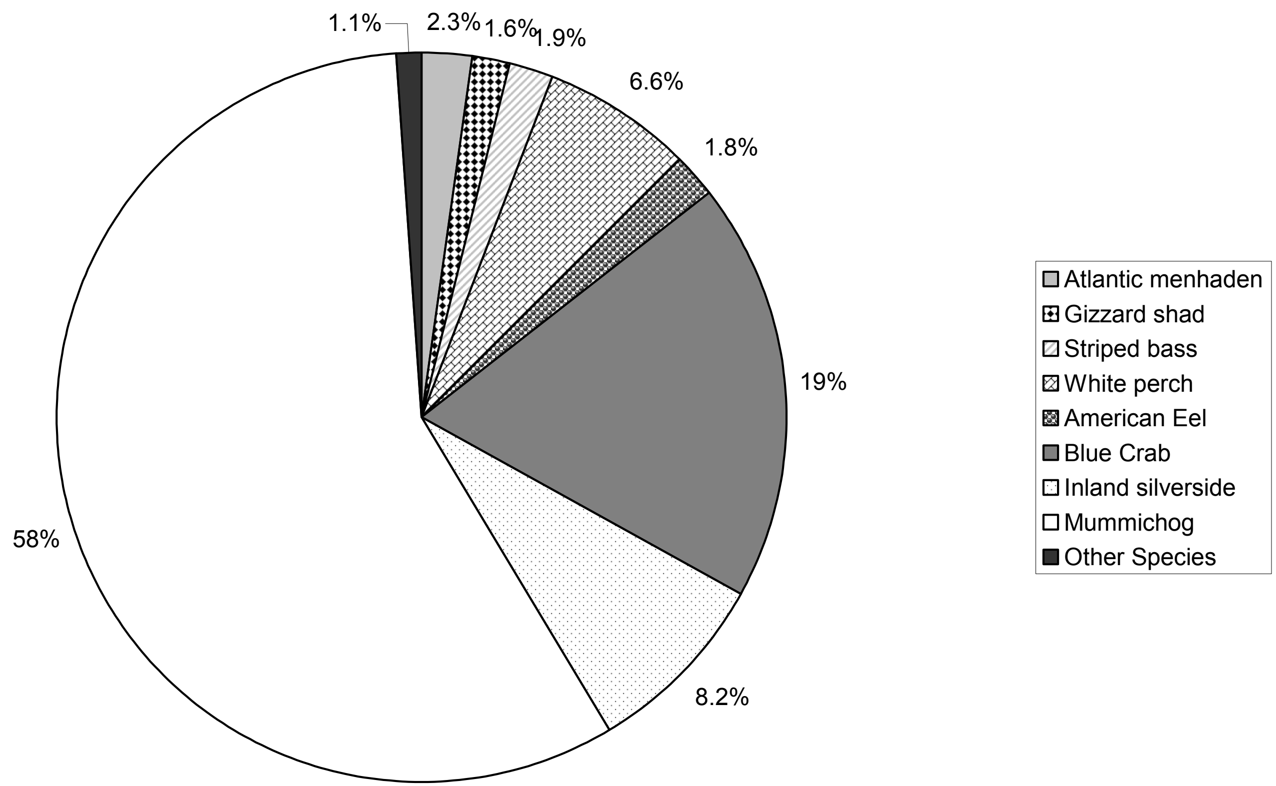
Percent CPUE Dominance of Fish Caught in the PRSA – Combined Fall 1999 and Spring 2000



"Other Species" category includes blueback herring, bluefish, bluegill, brown bullhead, channel catfish, common carp, green sunfish, largemouth bass, redear sunfish, spotted hake, striped killifish, summer flounder, weakfish, white catfish, and white sucker.

Excludes incidental catch for each gear types (e.g., silversides in gill nets).

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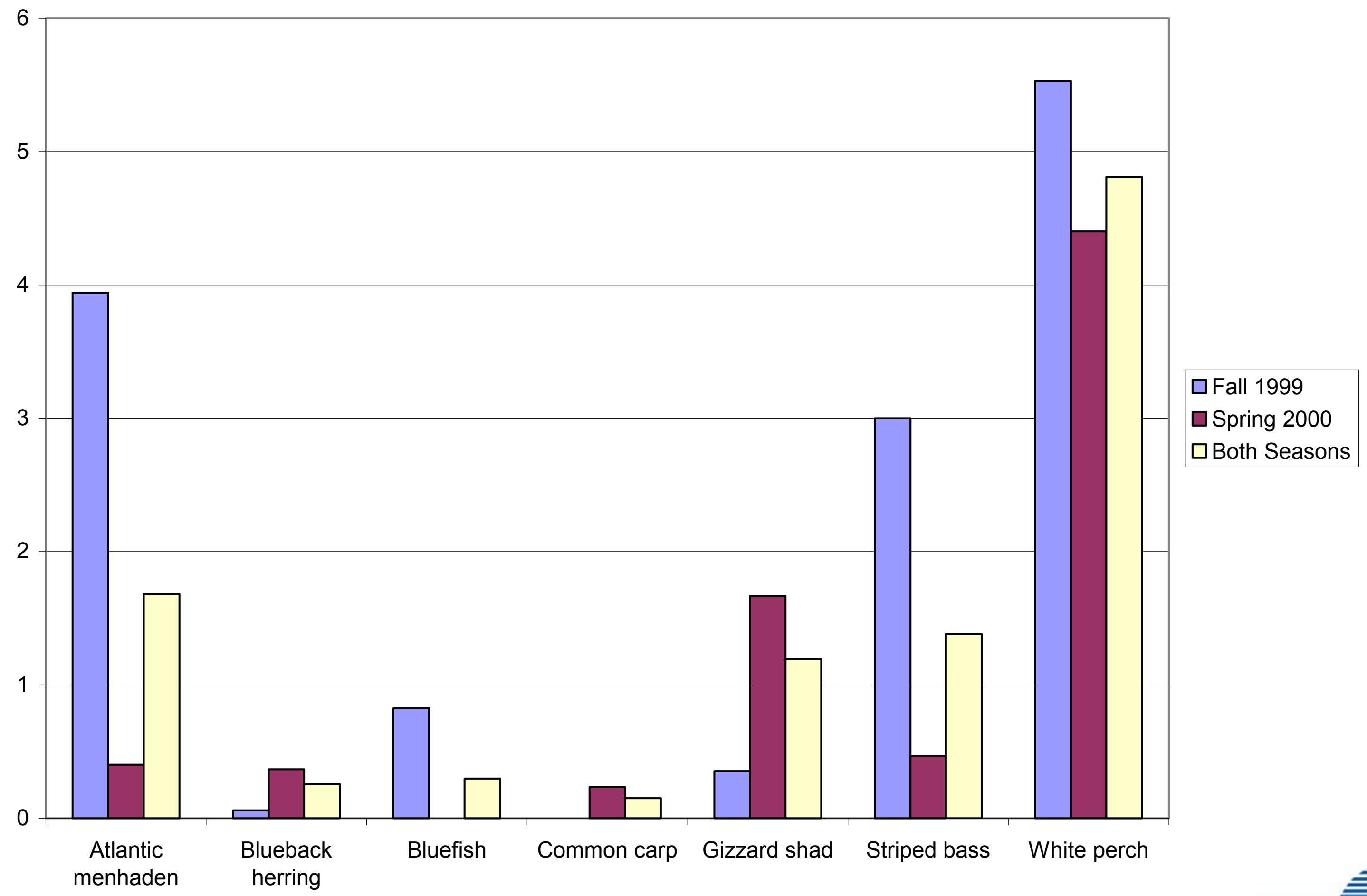
CPUE for Fish Collected by Gillnet from the PRSA



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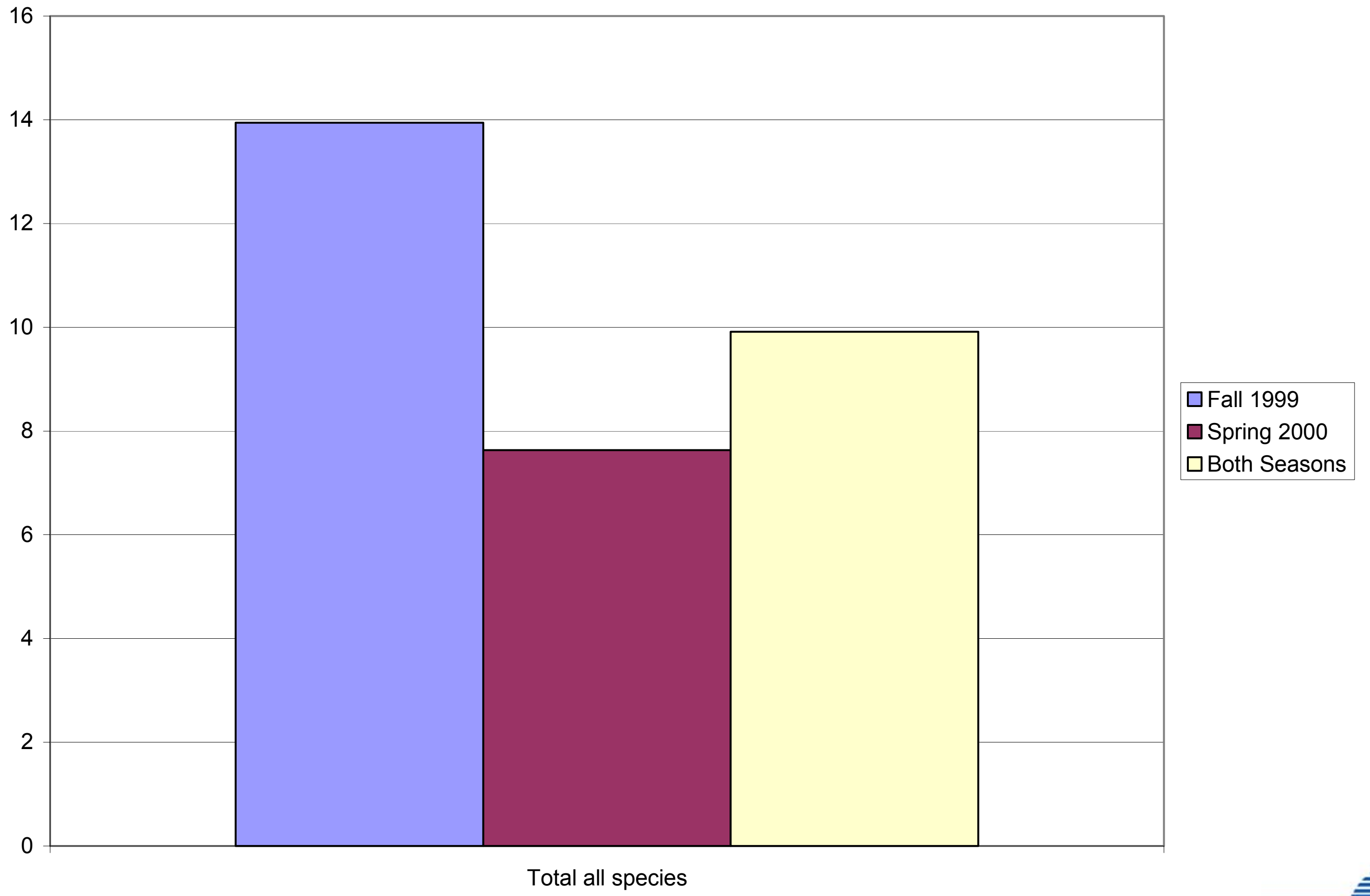
CPUE for Fish Collected by Gillnet from the PRSA



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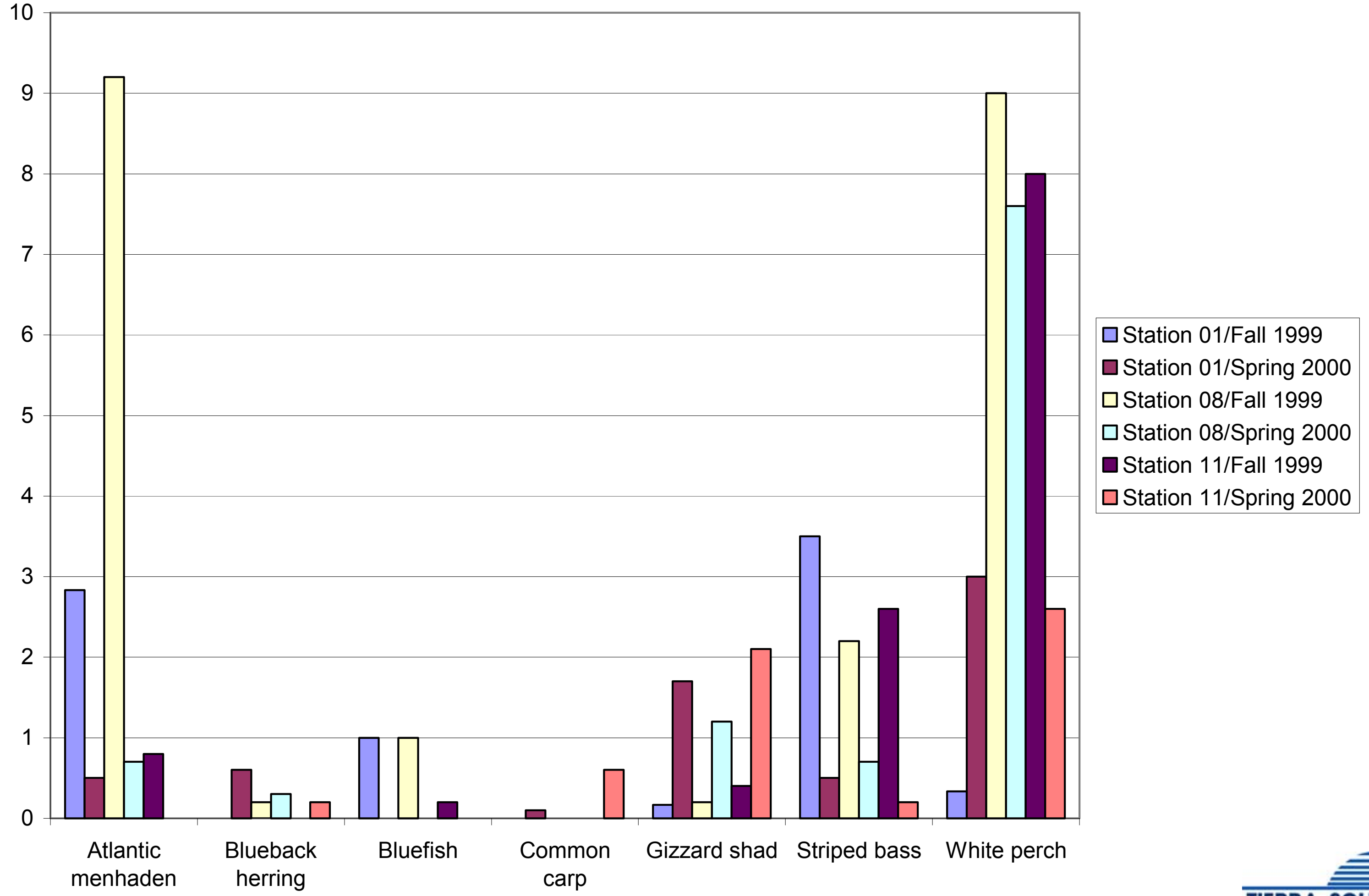
CPUE for Fish Collected by Gillnet from the PRSA by Station and Season



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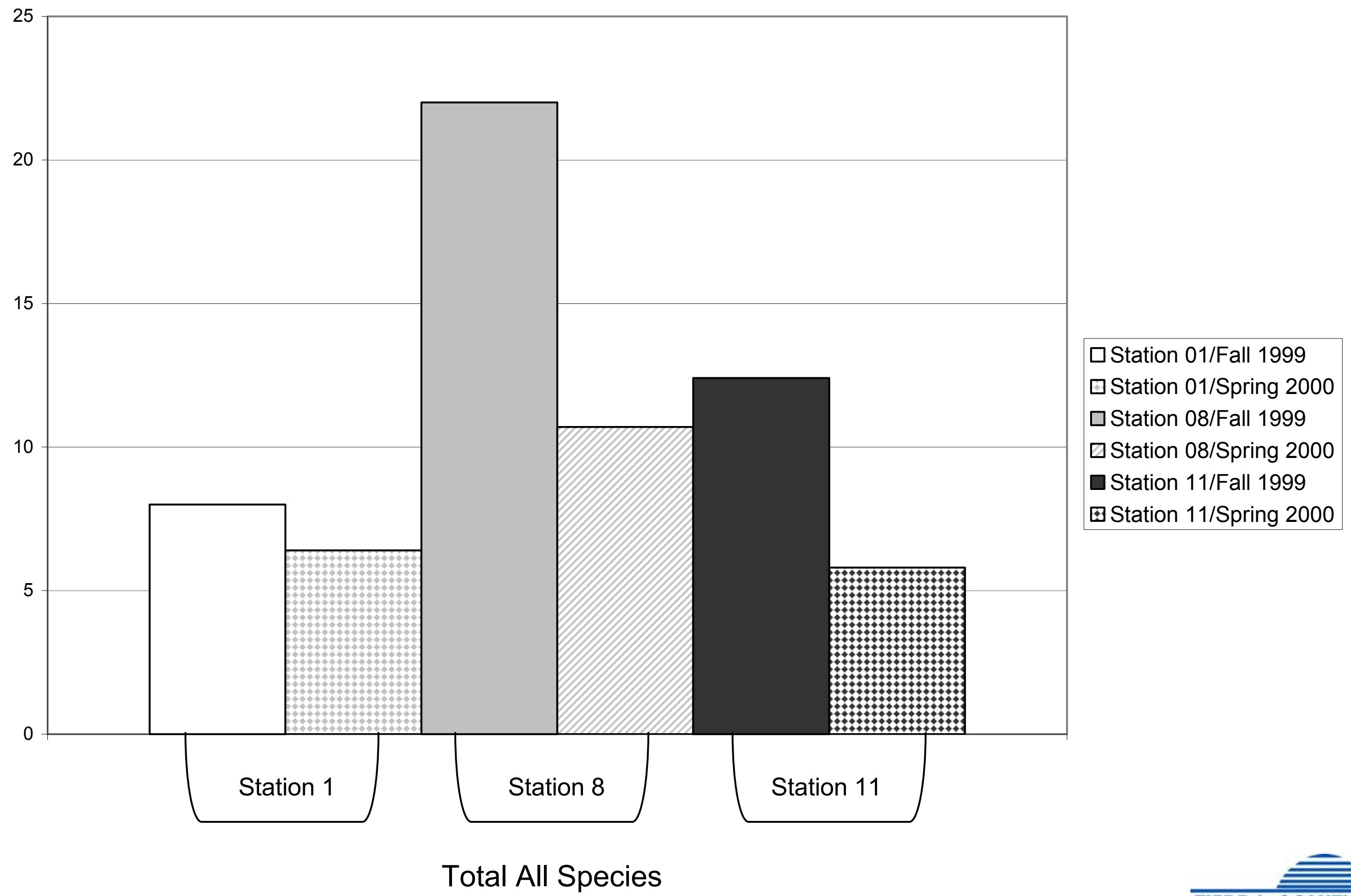
CPUE for All Fish Species Collected by Gillnet from the PRSA by Station and Season



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Summary of Lengths and Weights for Fish Collected from the PRSA

		Combined Fall 1999 and Spring 2000					
		Length (mm)			Weight (g)		
	N[a]	Range	Mean	SD[b]	Range	Mean	SD[b]
American eel	20	230 - 630	366	102	20 - 499	120	119
Atlantic menhaden	57	86 - 375	307	67	9 - 691	340	154
Blueback herring	9	225 - 265	240	13	95 - 197	130	29
Bluefish	6	176 - 335	247	68	53 - 112	99.7	23
Brown bullhead	2	278 - 280	279	1.4	320 - 321	321	0.71
Channel catfish	1	--	193	--	--	78	--
Common carp	7	460 - 730	562	88	1,400 - 3,487	2573	717
Gizzard shad	50	352 - 495	442	29	391 - 1,763	1103	275
Striped bass	48	206 - 730	396	137	88 - 3,682	933	924
Weakfish	2	220 - 234	227	10	102 - 143	123	29
White catfish	4	122 - 360	280	109	237 - 764	482	244
White perch	164	132 - 310	206	40	41 - 428	161	90
White sucker	1	--	425	--	--	965	--

Notes:

[a] Only intact fish for which complete measurements were available (length, weight) were included in this analysis.

[b] SD = Standard Deviation

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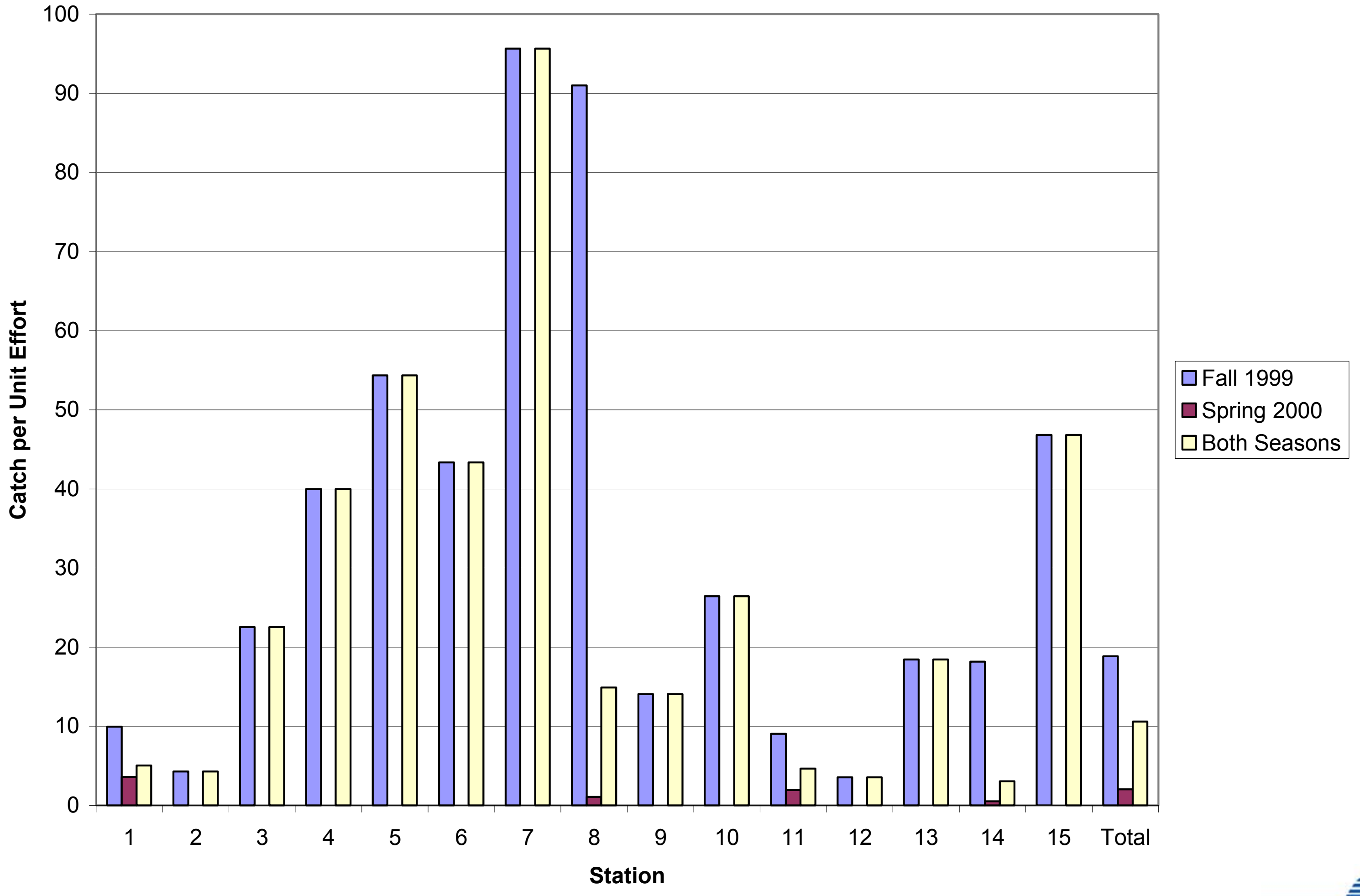
CPUE for Mummichog Collected from the PRSA



Summary of Length and Weight Data for Mummichog Collected from the PRSA

Station	Males						
	(n)	Length Range (mm)	Average Length (mm)	Length SD [a]	Weight Range (g)	Average Weight (g)	Weight SD [a]
Fall 1999	1233	41 - 114	66.7	14.4	1.0 - 21	4.7	3.9
Spring 2000	158	45 - 110	69.8	14.4	1.0 - 19	4.7	3.5
Combined Total	1391	41 - 114	67.1	14.4	1.0 - 21	4.7	3.9

Station	Females						
	(n)	Length Range (mm)	Average Length (mm)	Length SD [a]	Weight Range (g)	Average Weight (g)	Weight SD [a]
Fall 1999	1785	40 - 117	70.1	16.6	1.0 - 31	5.7	5.0
Spring 2000	157	45 - 130	79.2	16.5	1.0 - 28	7.9	5.0
Combined Total	1972	40 - 130	70.8	16.8	1.0 - 31	5.9	5.1

Station	Sex Ratio M : F
Fall 1999	1 : 1.45
Spring 2000	1.0 : 0.99
Combined Total	1 : 1.40

Notes:

[a] SD - standard deviation

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CPUE for Blue Crab Collected by Crab Trap from the PRSA

Sampling Event	No. of Crabs Collected[a]	No. of Traps Set	CPUE
Fall 1999	1269	262	4.84
Spring 2000	231	88	2.63
Combined Total	**1500**	**350**	**4.29**

Notes:

[a] This number includes crabs collected that were not measured in length-weight analysis.

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Summary of Lengths and Weights for Blue Crab Collected from the PRSA

Sampling Event	No. of Crabs	Length Range (mm)	Length Average (mm)	Length SD[a]	Weight Range (g)	Weight Average (g)	Weight SD[a]
Fall 1999	1,210	64 - 192	121	16	34 - 269	106	39
Spring 2000	229	161 - 158	110	16	13 - 217	85	29
Combined Total	1,439	61 - 192	119	16	13 - 269	103	38

Notes:

[a] SD = Standard Deviation

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Supplemental Fish Collection Program – August 2001

- Not a community survey
- Focused collection effort for supplemental fish tissue data – edible fillets for human health risk assessment
- Target species:
  - American eel
  - Catfish (i.e., catfish or bullhead)
  - Carp
- Multiple sampling gear types
- One week sampling effort

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Summary of 2001 Passaic River Supplemental Fish Collection Efforts – Species Caught

	Date	8/6/2001								8/7/2001								8/8/2001								8/9/2001								8/10/2001							
Sampling Gear Type	Species / Sampling Location	American Eel	Brown Bullhead	White Catfish	White Perch	Atlantic Menhaden	Striped Bass	Mummichog	Blue Crab	American Eel	Brown Bullhead	White Catfish	White Perch	Atlantic Menhaden	Striped Bass	Mummichog	Blue Crab	American Eel	Brown Bullhead	White Catfish	White Perch	Atlantic Menhaden	Striped Bass	Mummichog	Blue Crab	American Eel	Brown Bullhead	White Catfish	White Perch	Atlantic Menhaden	Striped Bass	Mummichog	Blue Crab	American Eel	Brown Bullhead	White Catfish	White Perch	Atlantic Menhaden	Striped Bass	Mummichog	Blue Crab
Eel Traps	1																2									--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2																									--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3	1																																--	--	--	--	--	--	--	--
	4																	1															2	--	--	--	--	--	--	--	--
	5	1																2								1								--	--	--	--	--	--	--	--
	6																								1	1								--	--	--	--	--	--	--	--
	7																1																1	--	--	--	--	--	--	--	--
	8	3								2																								--	--	--	--	--	--	--	--
	9																																	--	--	--	--	--	--	--	--
	10								1																									--	--	--	--	--	--	--	--
	11																																	--	--	--	--	--	--	--	--
Gill Nets	1										5	1		1			2		2						5					1			9	--	--	--	--	--	--	--	--
	2				3				2																3								11	--	--	--	--	--	--	--	--
	3											1		5			3					5			8					2			5	--	--	--	--	--	--	--	--
	4				1										1		3					4			8								1	--	--	--	--	--	--	--	--
Trotlines	1									1																								--	--	--	--	--	--	--	--
	2																	1										1						--	--	--	--	--	--	--	--
	3								1									--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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	5																	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	6								2									--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trapnets	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--				2						1		6				6	--	--	--	--	--	--	--	--
	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		1		1												1	--	--	--	--	--	--	--	--
	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--				5						1		7				2	--	--	--	--	--	--	--	--
	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		1								7						2	--	--	--	--	--	--	--	--
	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--										1		2	1			2	--	--	--	--	--	--	--	--
TOTAL		5	0	0	4	0	0	0	6	3	5	2	0	6	1	0	11	4	4	0	8	9	0	0	25	2	10	1	15	4	0	1	43	0	0	0	0	0	0	0	0

Note:
-- = sampling not conducted.

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Conclusions

- PRSA fish community is limited – dominated by mummichog and blue crab
- Diversity appears low – likely due to habitat limitations

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Preliminary Sediment Quality Triad (SQT) Assessment

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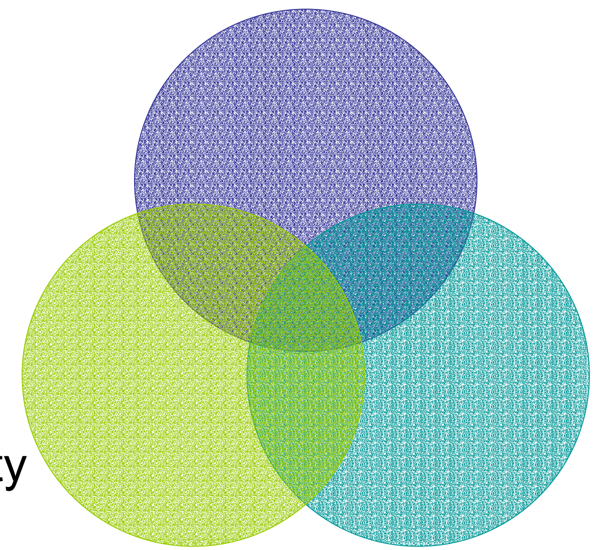
The Sediment Quality Triad

Sediment Chemistry
(contaminant analyses)



Sediment Toxicity
(laboratory
bioassays)

Benthic
Invertebrate
Communities
(community analyses)

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SQT Potential Scenarios

Contamination	Toxicity	Alteration	Scenario
+	+	+	Strong evidence for impacts from chemical contamination
-	-	-	Strong evidence for no impacts from chemical contamination
+	-	-	Chemical contaminants are not toxic or bioavailable
-	+	-	Unmeasured chemical or physical conditions exist that are causing toxicity
-	-	+	Impacts are not caused by chemical contamination
+	+	-	Chemical contaminants may be causing toxicity
-	+	+	Unmeasured chemical or physical conditions exist that are causing toxicity and community impacts
+	-	+	Chemical contaminants are not bioavailable or community alterations are not due to toxic chemicals

Notes:
"+" = contamination, toxicity, and/or community alterations present
"-" = contamination, toxicity, and/or community alterations absent

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Objectives

- Compare sediment quality between the PRSA and Mullica River reference area
- Develop a qualitative, weight-of-evidence description for each PRSA station
- Rank and compare relative sediment quality among stations
- Identify which physico-chemical variables may influence sediment toxicity and/or benthic community alterations in PRSA

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Methods

- Chemistry, toxicity, benthic community analyses documented in previous presentations
- Preliminary statistical analyses
  - Comparison of PRSA to Reference Area (RA)
  - Sediment quality guideline quotients (SQGQs)
  - Nonparametric Spearman correlations
- PRSA station classifications
- Weight-of-evidence assessment

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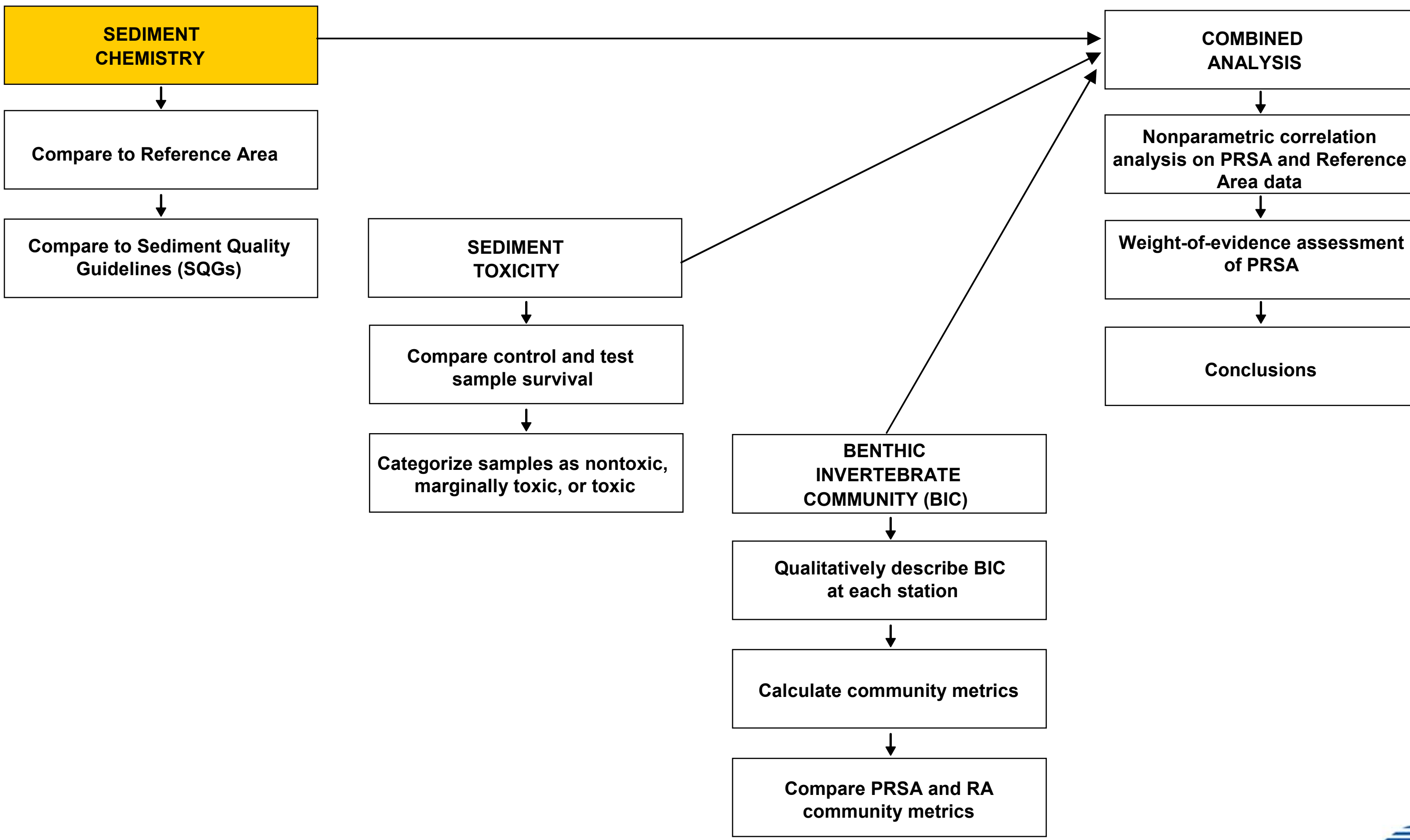
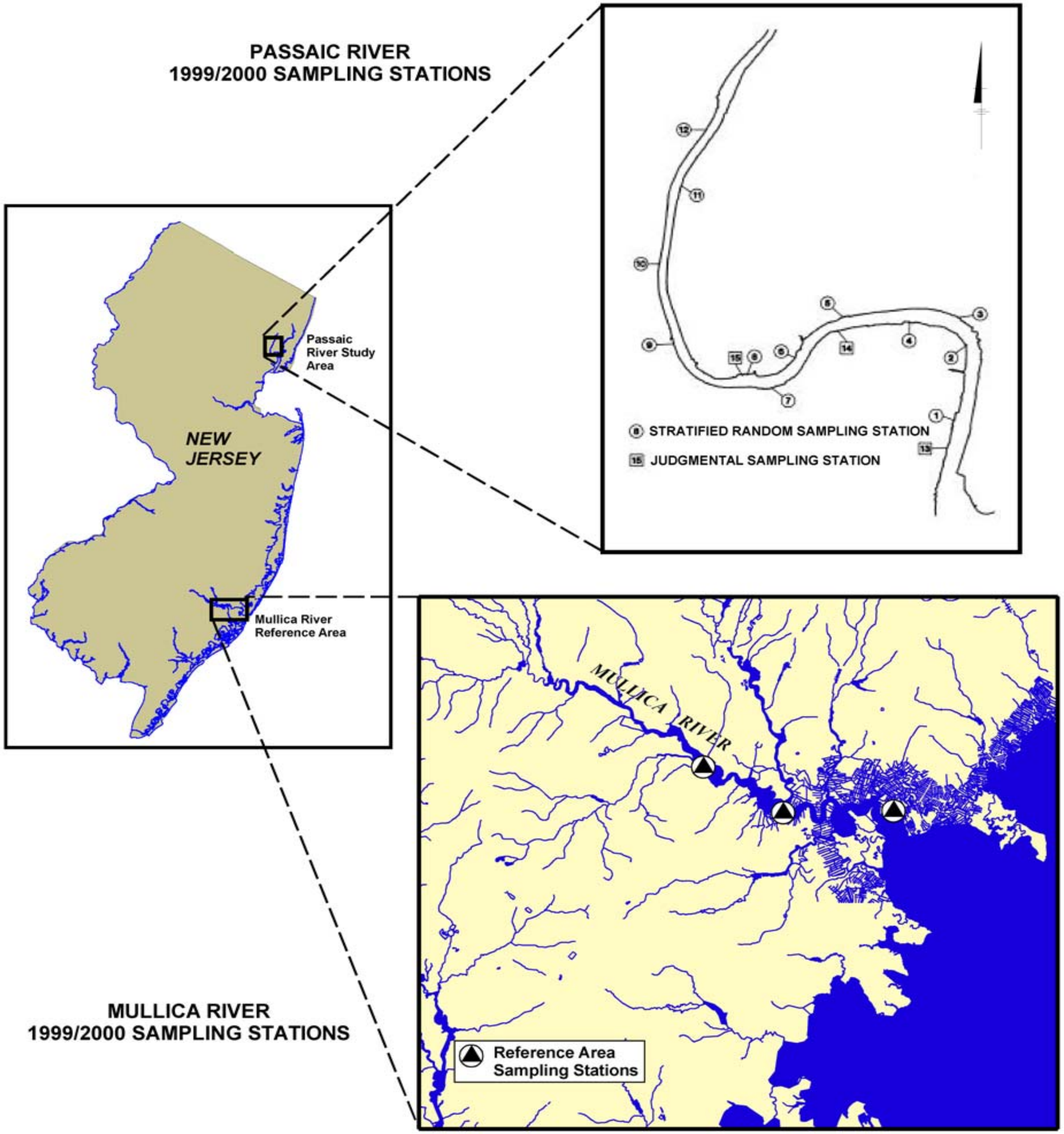
Steps in the SQT



Sampling Stations in the PRSA and Mullica River Reference Area



PRSA Sediment Chemistry Data

- Described in detail in May 29, 2002 presentation
- Chemistry data from central sampling grid at each ESP station used in SQT – synoptically collected with toxicity and benthic invertebrate community data

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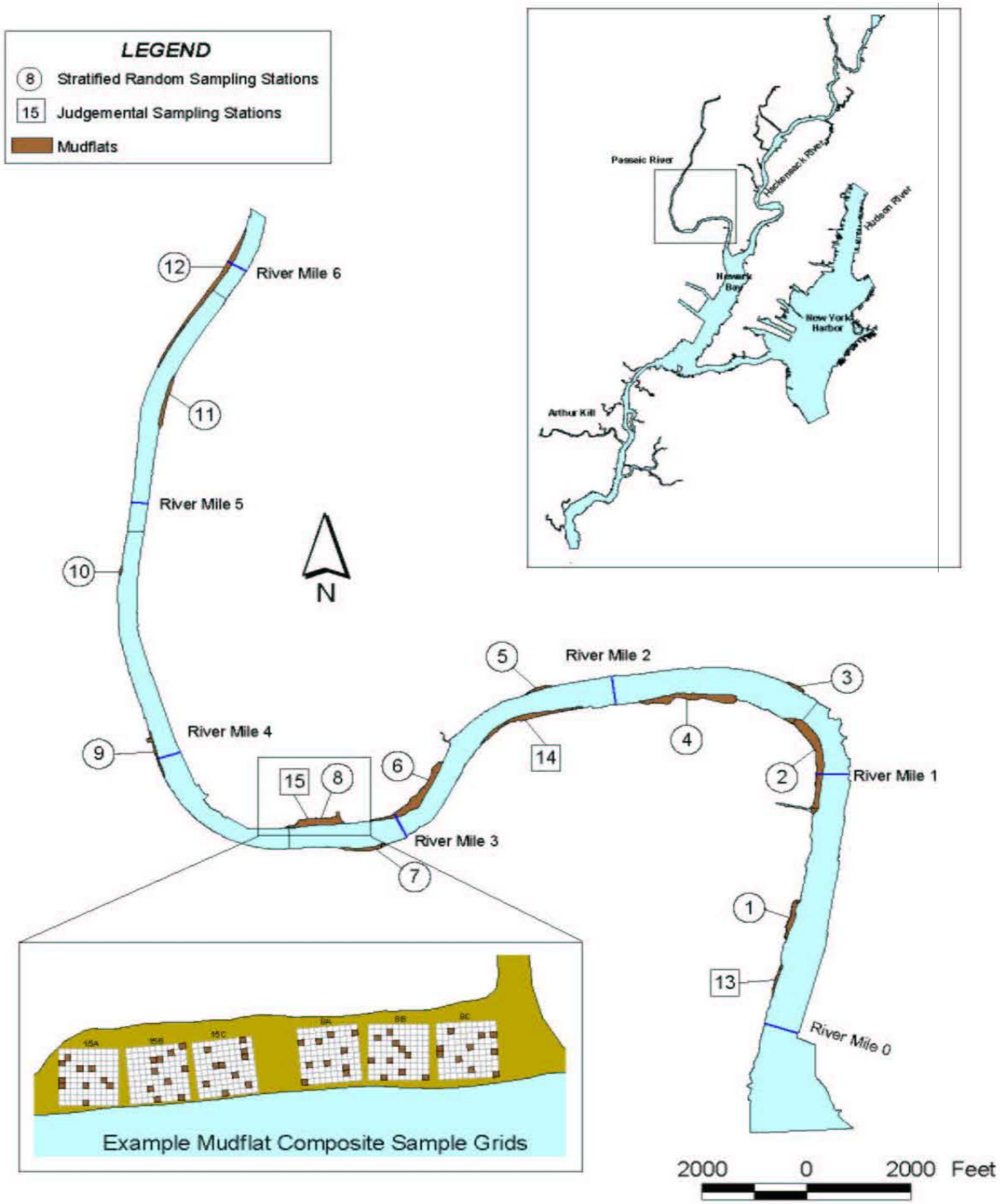

Figure 1. Passaic River Study Area and Sampling Stations

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Chemicals Evaluated in the SQT

Inorganic Chemicals	Miscellaneous	Polycyclic Aromatic Hydrocarbons (PAHs)
Aluminum	Ammonia Nitrogen	High Molecular Weight PAHs (13)[a] [H-PAHs]
Antimony	Percent Fines	Low Molecular Weight PAHs (13)[a] [L-PAHs]
Arsenic	Total Organic Carbon	Total PAHs (13)[a]
Barium	Salinity	
Beryllium	pH	*Semivolatile Compounds*
Cadmium		1,4-Dichlorobenzene
Calcium	*Organotins*	2,4-Dichlorophenol
Chromium	Dibutyltin	bis(2-Ethylhexyl)phthalate
Cobalt	Monobutyltin	Butyl benzyl phthalate
Copper	Tributyltin	Carbazole
Iron		Dibenzofuran
Lead	*Pesticides/Herbicides*	Dibenzothiophene
Magnesium	Total DDT	Di-n-Butylphthalate
Manganese		Di-n-Octylphthalate
Mercury	*Polychlorinated Biphenyls (PCBs)*	N-Nitrosodiphenylamine
Nickel	Total PCBs - Sum of Homologue Groups	
Potassium		
Selenium	*Polychlorinated Dibenzo-* p-*Dioxins and Furans (PCDD/Fs)*	
Silver	WHO TEQ(Fish)	
Sodium		
Thallium		
Vanadium		
Zinc		

Notes:

[a] Calculated using a limited congener set (13 PAHs) as described in Long et al., 1995.

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Summary of Sediment Data for Central Sampling Grid of PRSA Stations

Analyte	Unit	N	Minimum	Min. Station(s)	Maximum	Max. Station(s)	Average[a]
Inorganic Chemicals							
Aluminum	mg/kg	15	7,150	3	22,300	13	16,177
Antimony	mg/kg	15	ND	3	1.6	10	0.84
Arsenic	mg/kg	15	5	3	15	4	11
Barium	mg/kg	15	59	3	341	13	168
Beryllium	mg/kg	15	0.50	3	1.2	13	0.88
Cadmium	mg/kg	15	1.5	3	6.7	4	4.2
Calcium	mg/kg	15	3,070	3	9,450	11	6,263
Chromium	mg/kg	15	59	3	182	13	137
Cobalt	mg/kg	15	5.4	3	14	4	11
Copper	mg/kg	15	79	3	273	7	191
Iron	mg/kg	15	16,100	3	40,600	13	32,067
Lead	mg/kg	15	101	3	334	11	257
Magnesium	mg/kg	15	3,300	3	9,480	13	6,779
Manganese	mg/kg	15	225	3	861	15	538
Mercury	mg/kg	15	0.91	3	5.8	11	3.1
Nickel	mg/kg	13	32	5	48	6	40
Potassium	mg/kg	10	1,130	3	4,930	13	2,736
Selenium	mg/kg	15	ND	1-3; 13	2.2	11	1.3
Silver	mg/kg	15	1.4	3	4.9	4	3.5
Sodium	mg/kg	15	880	15	9,440	1	4,019
Thallium	mg/kg	11	0.48	3	3.7	15	2.4
Vanadium	mg/kg	15	21	3	55	13	44
Zinc	mg/kg	13	346	2	641	11	541
Miscellaneous							
Ammonia Nitrogen	mg/kg	15	81	3	530	11	316
Percent Fines	%	15	30	3	90	14	73
Total Organic Carbon	mg/kg	15	9,300	3	46,700	8	33,913
Salinity	ppth	15	0.59	11	19	1	6.7
pH	pH Units	15	6.8	15	8.1	6	7.2

Note:
[a] 1/2 detection limit used to calculate average if station value was a non-detect
ND = not detected.

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Summary of Sediment Data for Central Sampling Grid of PRSA Stations (cont.)

Analyte	Unit	N	Minimum	Min. Station(s)	Maximum	Max. Station(s)	Average[a]
Organotins							
Monobutyltin	µg/kg	15	0.23	3	4.4	12	0.85
Dibutyltin	µg/kg	15	2.3	2	59	12	9.3
Tributyltin	µg/kg	15	ND	6,8	89	7	26
Pesticides/Herbicides							
Total DDT	µg/kg	15	ND	4,5,10,15	1,210	9	176
Polychlorinated Biphenyls (PCBs)							
Total PCBs - Homologue Groups	µg/kg	15	907	3	2,610	15	1,736
ych							
PCDD/F TEQ(Fish)	µg/kg	15	0.18	3	2.4	11	0.54
ycy							
LMW PAHs	µg/kg	15	2,770	3	9,020	11	5,839
HMW PAHs	µg/kg	15	10,900	3	39,200	11	23,333
Total PAHs	µg/kg	15	13,600	3	48,200	11	29,167
miv							
1,4-Dichlorobenzene	µg/kg	15	ND	6-9; 11,12	190	4	889
2,4-Dichlorophenol	µg/kg	15	ND	1-13;15	560	14	1,090
bis(2-Ethylhexyl)phthalate	µg/kg	15	6,400	3	33,000	11	13,333
Butyl benzyl phthalate	µg/kg	15	100	3	360,000	11	24,854
Carbazole	µg/kg	15	170	5	2,750	6	915
Di-n-Butylphthalate	µg/kg	15	ND	2; 4-10; 12-15	1,100	11	984
Di-n-Octylphthalate	µg/kg	15	ND	6-8; 11-13	980	9	1,180
Dibenzofuran	µg/kg	15	ND	6,7,8,12,14	640	11	776
Dibenzothiophene	µg/kg	15	65	3	294	11	193
N-Nitrosodiphenylamine	µg/kg	15	ND	4; 6-9; 11-14	180	15	958

Note:
[a] 1/2 detection limit used to calculate average if station value was a non-detect
ND = not detected.

TIERRA SOLUTIONS, INC.

Summary of Sediment Data for Central Sampling Grid of Reference Area Stations

Analyte	Unit	N	Minimum	Min. Station(s)	Maximum	Max. Station(s)	Average[a]
Inorganic Chemicals							
Aluminum	mg/kg	3	18,300	21	23,400	22	21,167
Antimony	mg/kg	3	ND	21,23	1.4	22	0.87
Arsenic	mg/kg	3	15	22	33	21	22
Barium	mg/kg	3	56	21	63	22	60
Beryllium	mg/kg	3	1.1	23	1.5	21	1.3
Cadmium	mg/kg	3	0.83	23	2.4	21	1.4
Calcium	mg/kg	3	4,690	22	6,120	21	5,517
Chromium	mg/kg	3	64	21	74	23	70
Cobalt	mg/kg	3	8.9	21	10	23	9.7
Copper	mg/kg	3	28	21	37	23	32
Iron	mg/kg	3	41,400	23	61,600	21	48,600
Lead	mg/kg	3	46	22	56	21	50
Magnesium	mg/kg	3	9,630	21	11,400	23	10,443
Manganese	mg/kg	3	225	21	308	23	267
Mercury	mg/kg	3	0.30	22	0.39	23	0.33
Nickel	mg/kg	1	30	21	30	21	NA
Potassium	mg/kg	3	3,410	21	6,110	23	5,017
Selenium	mg/kg	3	ND	NA	ND	NA	NA
Silver	mg/kg	3	0.31	21	0.82	23	0.58
Sodium	mg/kg	3	9,460	21	18,500	23	12,987
Thallium	mg/kg	3	ND	21,22	1.7	23	1.01
Vanadium	mg/kg	3	62	21	70	22	66
Zinc	mg/kg	1	155	21	155	21	NA
Miscellaneous							
Ammonia Nitrogen	mg/kg	3	240	23	510	21	360
Percent Fines	%	3	74	21	88	22	82
Total Organic Carbon	mg/kg	3	28,800	23	66,200	21	42,600
Salinity	ppth	3	0.85	22	23	23	11
pH	pH Units	3	6.6	21	7.3	23	6.95

Note:
[a] 1/2 detection limit used to calculate average if station value was a non-detect
NA = not applicable.
ND = not detected.

TIERRA SOLUTIONS, INC.

Summary of Sediment Data for Central Sampling Grid of Reference Area Stations (cont.)

Analyte	Unit	N	Minimum	Min. Station(s)	Maximum	Max. Station(s)	Average[a]
Organotins							
Monobutyltin	µg/kg	2	ND	NA	ND	NA	NA
Dibutyltin	µg/kg	2	ND	NA	ND	NA	NA
Tributyltin	µg/kg	2	ND	NA	ND	NA	NA
Pesticides/Herbicides							
Total DDT	µg/kg	3	9	23	26	21	16
Polychlorinated Biphenyls (PCBs)							
Total PCBs - Homologue Groups	µg/kg	3	32	21	45	23	38
Polychlorinated Dibenzo-p-Dioxins and Furans (PCDD/Fs)							
PCDD/F TEQ(Fish)	µg/kg	3	0.0080	23	0.0094	21	0.0086
Polycyclic Aromatic Hydrocarbons							
LMW PAHs	µg/kg	3	136	22	260	21	183
HMW PAHs	µg/kg	3	418	22	533	21	493
Total PAHs	µg/kg	3	554	22	793	21	676
Semivolatile Compounds							
1,4-Dichlorobenzene	µg/kg	3	ND	NA	ND	NA	NA
2,4-Dichlorophenol	µg/kg	3	ND	NA	ND	NA	NA
bis(2-Ethylhexyl)phthalate	µg/kg	3	ND	NA	ND	NA	NA
Butyl benzyl phthalate	µg/kg	3	ND	NA	ND	NA	NA
Carbazole	µg/kg	3	ND	NA	ND	NA	NA
Di-n-Butylphthalate	µg/kg	3	ND	NA	ND	NA	NA
Di-n-Octylphthalate	µg/kg	3	ND	NA	ND	NA	NA
Dibenzofuran	µg/kg	3	ND	NA	ND	NA	NA
Dibenzothiophene	µg/kg	3	4.1	22	6.5	21	5.1
N-Nitrosodiphenylamine	µg/kg	3	ND	NA	ND	NA	NA

Note:
[a] 1/2 detection limit used to calculate average if station value was a non-detect
NA = not applicable.
ND = not detected.

TIERRA SOLUTIONS, INC.

Ratio-to-Reference (RTR) Calculations for PRSA

Chemical	PR13	PR1	PR2	PR3	PR4	PR14	PR5	PR6	PR7	PR8	PR15	PR9	PR10	PR11	PR12
Inorganic Chemicals															
Aluminum	**1.1**	0.9	0.6	0.3	0.9	0.7	0.7	0.8	0.8	0.9	0.7	0.5	0.7	0.8	0.8
Antimony	0.5	0.5	**1.3**	0.5	**1.3**	**1.1**	**1.2**	**1.1**	**1.3**	**1.8**	1.0	0.3	**1.8**	0.5	0.3
Arsenic	0.6	0.7	0.6	0.2	0.7	0.5	0.4	0.5	0.6	0.5	0.5	0.4	0.6	0.5	0.4
Barium	**5.7**	**3.4**	**1.8**	1.0	**2.5**	**2.3**	**2.0**	**2.4**	**4.0**	**3.1**	**3.2**	**2.0**	**2.9**	**2.9**	**2.5**
Beryllium	0.9	0.9	0.9	0.4	0.9	0.7	0.6	0.7	0.7	0.7	0.7	0.5	0.7	0.7	0.6
Cadmium	**3.4**	**4.3**	**2.1**	**1.1**	**4.9**	**3.9**	**3.4**	**2.3**	**2.0**	**2.2**	**4.3**	**3.5**	**4.5**	**2.3**	**2.3**
Calcium	**1.3**	**1.1**	0.7	0.6	**1.3**	**1.1**	0.9	**1.3**	1.0	**1.3**	**1.3**	0.9	**1.5**	**1.7**	**1.1**
Chromium	**2.6**	**2.6**	**1.7**	0.8	**2.6**	**2.2**	**1.7**	**2.0**	**1.8**	**2.0**	**1.8**	**1.8**	**2.1**	**1.9**	**1.6**
Cobalt	**1.4**	**1.4**	**1.1**	0.6	**1.4**	**1.1**	1.0	**1.3**	**1.2**	**1.3**	**1.2**	0.9	**1.2**	**1.2**	**1.0**
Copper	**7.1**	**6.9**	**4.7**	**2.5**	**7.1**	**6.3**	**4.9**	**6.6**	**8.7**	**6.5**	**6.2**	**5.3**	**6.5**	**6.3**	**5.5**
Iron	0.8	0.8	0.5	0.3	0.8	0.7	0.6	0.7	0.6	0.7	0.7	0.6	0.7	0.7	0.6
Lead	**5.3**	**5.4**	**3.6**	**2.0**	**5.3**	**4.7**	**4.0**	**5.5**	**6.4**	**6.4**	**5.5**	**5.1**	**5.9**	**6.7**	**5.3**
Magnesium	0.9	0.9	0.5	0.3	0.9	0.7	0.6	0.7	0.6	0.6	0.6	0.5	0.7	0.7	0.5
Manganese	**2.3**	**1.9**	**1.1**	0.8	**1.9**	**2.2**	**1.6**	**1.8**	**1.5**	**2.6**	**3.2**	**1.8**	**2.5**	**2.7**	**2.2**
Mercury	**9.3**	**9.6**	**9.9**	**2.7**	**10.2**	**9.3**	**6.6**	**8.4**	**14.7**	**9.6**	**7.2**	**8.1**	**8.1**	**17.4**	**6.6**
Nickel	*R*	**1.5**	**1.3**	*R*	**1.5**	**1.3**	**1.1**	**1.6**	**1.4**	**1.5**	**1.3**	**1.2**	**1.4**	**1.5**	1.2
Potassium	1.0	0.8	0.5	0.2	0.8	0.5	0.6	*R*	*R*	*R*	0.3	0.3	0.5	*R*	*R*
Selenium	0.6	0.8	0.6	0.3	**2.4**	**1.7**	**1.7**	**3.1**	**2.4**	**2.8**	**1.8**	**2.0**	**2.1**	**3.1**	**2.7**
Silver	**7.8**	**7.6**	**3.8**	**2.4**	**8.5**	**6.9**	**5.4**	**5.9**	**6.6**	**6.4**	**6.4**	**5.0**	**7.5**	**5.7**	**6.2**
Sodium	0.7	0.7	0.3	0.2	0.5	0.4	0.3	0.4	0.2	0.2	0.1	0.2	0.2	0.1	0.1
Thallium	**1.8**	*R*	*R*	0.5	**2.7**	*R*	**3.0**	**2.3**	**1.5**	**2.1**	**3.7**	*R*	**3.6**	**2.7**	**2.2**
Vanadium	0.8	0.8	0.7	0.3	0.8	0.6	0.6	0.7	0.7	0.7	0.6	0.5	0.6	0.8	0.6
Zinc	*R*	**3.8**	**2.2**	*R*	**3.8**	**3.3**	**2.7**	**3.7**	**3.8**	**3.7**	**3.6**	**3.4**	**3.8**	**4.1**	**3.4**
Miscellaneous															
Ammonia Nitrogen	0.6	0.9	0.5	0.2	0.7	**1.2**	0.8	**1.4**	0.5	0.7	**1.3**	0.7	0.9	**1.5**	**1.3**
Total Organic Carbon	0.9	0.8	0.4	0.2	0.9	0.8	0.6	0.9	0.8	**1.1**	1.0	0.9	0.9	0.9	0.8
Percent Fines	**1.1**	1.0	0.9	0.4	1.0	**1.1**	1.0	0.9	0.7	0.9	1.0	0.9	1.0	0.8	0.9
pH	**1.0**	1.1	1.1	1.0	1.1	**1.0**	1.1	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Salinity	**1.1**	1.2	0.9	0.9	0.8	0.8	0.5	0.4	0.4	0.6	0.4	0.6	0.3	0.2	0.2

Notes:

Shading indicates a ratio greater than 1.0, includes ND values.

ND - not detected in the Reference Area

R - result value for this chemical was rejected

TIERRA SOLUTIONS, INC.

Ratio-to-Reference (RTR) Calculations for PRSA (cont.)

Chemical	PR13	PR1	PR2	PR3	PR4	PR14	PR5	PR6	PR7	PR8	PR15	PR9	PR10	PR11	PR12
Organotins															
Dibutyltin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Monobutyltin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tributyltin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pesticides/Herbicides															
Total DDT	**4.8**	**9.3**	**6.9**	**2.8**	**2.5**	**11**	**1.4**	**3.4**	**20**	**7.5**	**2.1**	**75**	**2.4**	**8.3**	**6.6**
PCDD/Fs															
PCDD/F TEQ	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCBs															
Total PCBs - Homologue Groups	**55**	**46**	**32**	**24**	**51**	**46**	**44**	**44**	**49**	**35**	**69**	**32**	**58**	**47**	**55**
PAHs															
HMW PAHs	**44**	**32**	**42**	**22**	**45**	**40**	**60**	**51**	**47**	**49**	**52**	**49**	**36**	**80**	**62**
LMW PAHs	**34**	**23**	**26**	**15**	**29**	**29**	**35**	**40**	**27**	**37**	**40**	**30**	**25**	**49**	**37**
Total PAHs	**42**	**30**	**38**	**20**	**40**	**37**	**53**	**48**	**42**	**46**	**49**	**44**	**33**	**71**	**55**
Semivolatile Compounds															
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbazole	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzothiophene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Octylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
Shading indicates a ratio greater than 1.0, includes ND values.
ND - not detected in the Reference Area
R - result value for this chemical was rejected

TIERRA SOLUTIONS, INC.

Sediment Quality Guideline Quotients (SQGQ)

- Average concentration of individual chemicals divided by respective SQG
- Average of these ratios calculated for each station to give SQGQ
- Sediments can be classified based on average SQGQ

TIERRA SOLUTIONS, INC.

Ratio of Chemical Concentration to Relevant Sediment Quality Guidelines (SQGs)

	MR23	MR22	MR21	PR13	PR1	PR2	PR3	PR4	PR14	PR5	PR6	PR7	PR8	PR15	PR9	PR10	PR11	PR12
Inorganic Chemicals																		
Antimony	0.018	0.056	0.030	0.016	0.016	0.044	0.018	0.044	0.038	0.040	0.038	0.044	0.064	0.036	0.012	0.064	0.016	0.012
Arsenic	0.24	0.22	0.47	0.18	0.20	0.19	0.071	0.21	0.16	0.13	0.15	0.196	0.15	0.15	0.13	0.17	0.15	0.13
Cadmium	0.086	0.091	0.25	0.49	0.61	0.30	0.16	0.698	0.55	0.48	0.32	0.28	0.31	0.61	0.50	0.64	0.32	0.32
Chromium	0.199	0.19	0.17	0.49	0.48	0.33	0.16	0.49	0.42	0.33	0.39	0.35	0.38	0.35	0.34	0.40	0.36	0.31
Copper	0.14	0.11	0.10	0.83	0.81	0.54	0.29	0.83	0.74	0.57	0.77	1.0	0.76	0.72	0.62	0.76	0.74	0.64
Lead	0.22	0.21	0.26	**1.2**	**1.2**	0.83	0.46	**1.2**	**1.1**	0.92	**1.3**	**1.5**	**1.5**	**1.3**	**1.2**	**1.4**	**1.5**	**1.2**
Manganese	0.18	0.16	0.13	0.37	0.31	0.18	0.13	0.30	0.35	0.25	0.29	0.24	0.41	0.51	0.29	0.40	0.43	0.35
Mercury	0.55	0.42	0.44	**4.4**	**4.5**	**4.6**	**1.3**	**4.8**	**4.4**	**3.1**	**3.9**	**6.9**	**4.5**	**3.4**	**3.8**	**3.8**	**8.2**	**3.1**
Nickel	*R*	*R*	0.57	*R*	0.89	0.74	*R*	0.88	0.73	0.63	0.93	0.79	0.85	0.73	0.67	0.78	0.86	0.66
Silver	0.22	0.16	0.084	**1.2**	**1.2**	0.59	0.38	**1.3**	**1.10**	0.84	0.92	1.0	1.00	**1.0**	0.78	**1.2**	0.89	0.97
Zinc	*R*	*R*	0.38	*R*	**1.4**	0.8	*R*	**1.5**	**1.3**	**1.0**	**1.4**	**1.5**	**1.4**	**1.4**	**1.3**	**1.4**	**1.6**	**1.3**
Pesticides																		
Total DDT	0.20	0.28	0.57	**1.7**	**3.3**	**2.4**	0.98	0.88	**3.8**	0.49	**1.2**	**7.0**	**2.6**	0.74	**26**	0.84	**2.9**	**2.3**
PCBs																		
Total PCBs - Homologue Groups	0.25	0.20	0.18	**12**	**10**	**7**	**5**	**11**	**10**	**9**	**9**	**10**	**7.3**	**15**	**6.7**	**12**	**10**	**12**
PAHs																		
LMW PAHs	0.049	0.043	0.082	**2.0**	**1.4**	**1.5**	0.877	**1.7**	**1.7**	**2.0**	**2.3**	**1.6**	**2.2**	**2.3**	**1.7**	**1.5**	**2.9**	**2.1**
HMW PAHs	0.055	0.044	0.056	**2.3**	**1.7**	**2.2**	**1.1**	**2.3**	**2.0**	**3.1**	**2.6**	**2.4**	**2.5**	**2.7**	**2.5**	**1.9**	**4.1**	**3.2**
Total PAHs	0.015	0.012	0.018	0.63	0.45	0.57	0.30	0.61	0.56	0.81	0.72	0.63	0.69	0.73	0.66	0.50	**1.1**	0.83
PCDD/Fs																		
2,3,7,8-TCDD	ND	ND	ND	0.010	0.010	0.022	0.006	0.014	0.020	0.013	0.014	0.026	0.011	0.012	0.014	0.012	0.092	0.011
Semivolatile Compounds																		
bis (2-Ethylhexyl)phthalate	ND	ND	ND	**5.7**	**5.3**	**2.9**	**2.4**	**5.7**	**4.2**	**3.8**	**3.8**	**5.3**	**4.9**	**5.3**	**3.7**	**4.5**	**12**	**5.7**

Notes:

Dieldrin and chlordane were not detected in the PRSA and Reference Area middle sampling grid in the Fall 1999 ESP sampling event.
Shading indicates ratio of greater than 1.0.
R - Rejected sample value
ND - Not detected

TIERRA SOLUTIONS, INC.

Sediment Quality Guideline Quotients (SQGQ)

SQGQ	Calculational Method
ER-M Quotient (PAH categories)	Calculated using ER-Ms for the following chemicals: As, Cd, Cr, Cu, Pb, Hg, H-PAH, L-PAH, Total PAHs, Total PCBs (homologue groups), Ag, Total DDT, and Zn. PAH categories calculated using the method of Long et al. (1995) with only 13 PAHs as listed in the individual PAHs ER-MQ below.
ER-M Quotient (PAH individual)	Calculated using ER-Ms for the following chemicals: As, Cd, Cr, Cu, Pb, Hg, 2-Methylnaphthalene, Diben[a,h]anthracene, Acenaphthene, Acenaphthylene, Anthracene, Benz[a]anthracene, Benzo[a]pyrene, Chrysene, Fluoranthene, Fluorene, Naphthalene, Phenanthrene, Pyrene, Total PCBs (homologue groups), Ag, Total DDT, and Zn.
SQGQ ER-M + Mn	Calculated using ER-Ms for the following chemicals: As, Cd, Cr, Cu, Pb, Hg, H-PAH, L-PAH, Total PAHs, Total PCBs (homologue groups), Ag, Total DDT, and Zn plus a benchmark value for Mn. PAH categories calculated using the method of Long et al. (1995) with only 13 PAHs as listed in the individual PAHs ER-MQ above.
SQGQ ER-M + BEP	Calculated using ER-Ms for the following chemicals: As, Cd, Cr, Cu, Pb, Hg, H-PAH, L-PAH, Total PAHs, Total PCBs (homologue groups), Ag, Total DDT, and Zn plus a benchmark value for bis(2-ethylhexyl)phthalate). PAH categories calculated using the method of Long et al. (1995) with only 13 PAHs as listed in the individual PAHs ER-MQ above.
SQGQ ER-M + PCDD/F TEQ	Calculated using ER-Ms for the following chemicals: As, Cd, Cr, Cu, Pb, Hg, H-PAH, L-PAH, Total PAHs, Total PCBs (homologue groups), Ag, Total DDT, and Zn plus a benchmark value for PCDD/F TEQ. PAH categories calculated using the method of Long et al. (1995) with only 13 PAHs as listed in the individual PAHs ER-MQ above.
SQGQ All benchmarks	Calculated using ER-Ms for the following chemicals: As, Cd, Cr, Cu, Pb, Hg, H-PAH, L-PAH, Total PAHs, Total PCBs (homologue groups), Ag, Total DDT, and Zn plus benchmark values for Mn, and PCDD/F TEQ. PAH categories calculated using the method of Long et al. (1995) with only 13 PAHs as listed in the individual PAHs ER-MQ above.

TIERRA SOLUTIONS, INC.

SQGQs for the PRSA and RA

Station	ER-M Quotient (PAH categories)	ER-M Quotient (PAH individual)	SQGQ ER-M + Mn	SQGQ ER-M + BEP	SQGQ ER-M + PCDD/F TEQ	SQGQ All Benchmarks
PRSA						
1	1.9	1.5	1.8	2.2	1.8	1.9
2	1.6	1.4	1.5	1.6	1.5	1.5
3	0.86	0.79	0.81	1.0	0.80	0.86
4	1.9	1.6	1.8	2.2	1.8	2.0
5	1.7	1.6	1.6	1.8	1.5	1.6
6	1.8	1.6	1.7	1.9	1.7	1.7
7	2.5	1.9	2.3	2.7	2.3	2.4
8	1.8	1.5	1.7	2.0	1.7	1.8
9	3.3	2.5	3.1	3.4	3.1	3.0
10	1.9	1.5	1.8	2.1	1.8	1.9
11	2.5	2.2	2.3	3.1	2.3	2.8
12	2.0	1.8	1.9	2.3	1.9	2.0
13	2.1	1.8	1.9	2.3	1.9	2.1
14	2.0	1.6	1.9	2.1	1.8	1.9
15	2.1	1.8	2.0	2.3	2.0	2.1
Reference Area						
21	0.22	0.15	0.22	0.23	0.21	0.21
22	0.15	0.10	0.15	0.16	0.14	0.15
23	0.19	0.12	0.19	0.19	0.17	0.18

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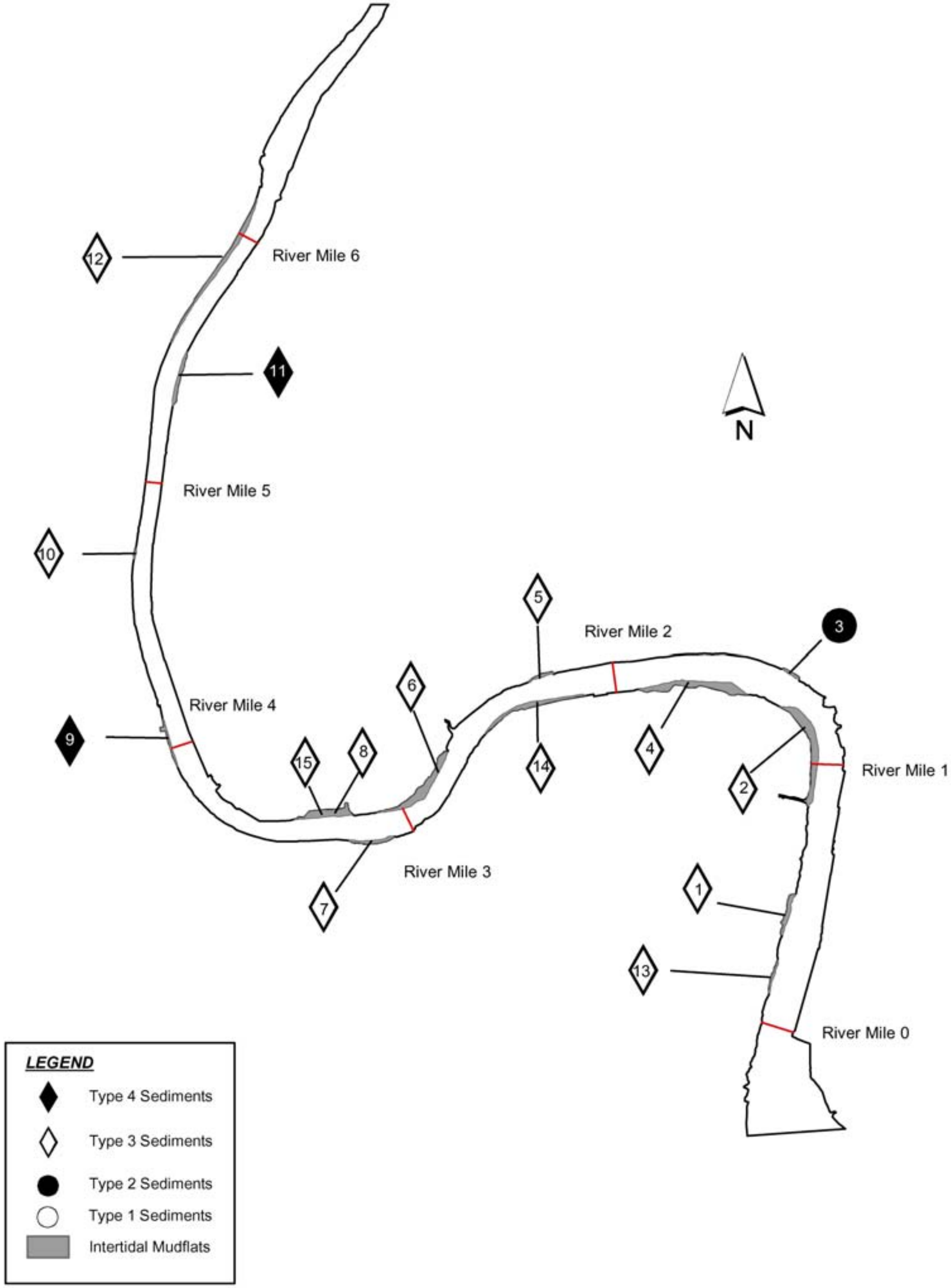
Classification System for PRSA and Reference Area Sediments based on SQGs/SQGQs

Sediment Type	**Number of SQGs Exceeded**	**Average SQGQ Value**
1	0	≤0.50
2	1-4	0.51-1.0
3	5-9	1.1-2.4
4	≥10	≥2.41

Notes:
PRSA-specific classification system.
Reference Area stations contain Type 1 sediments.

SQGQ Classification in the PRSA



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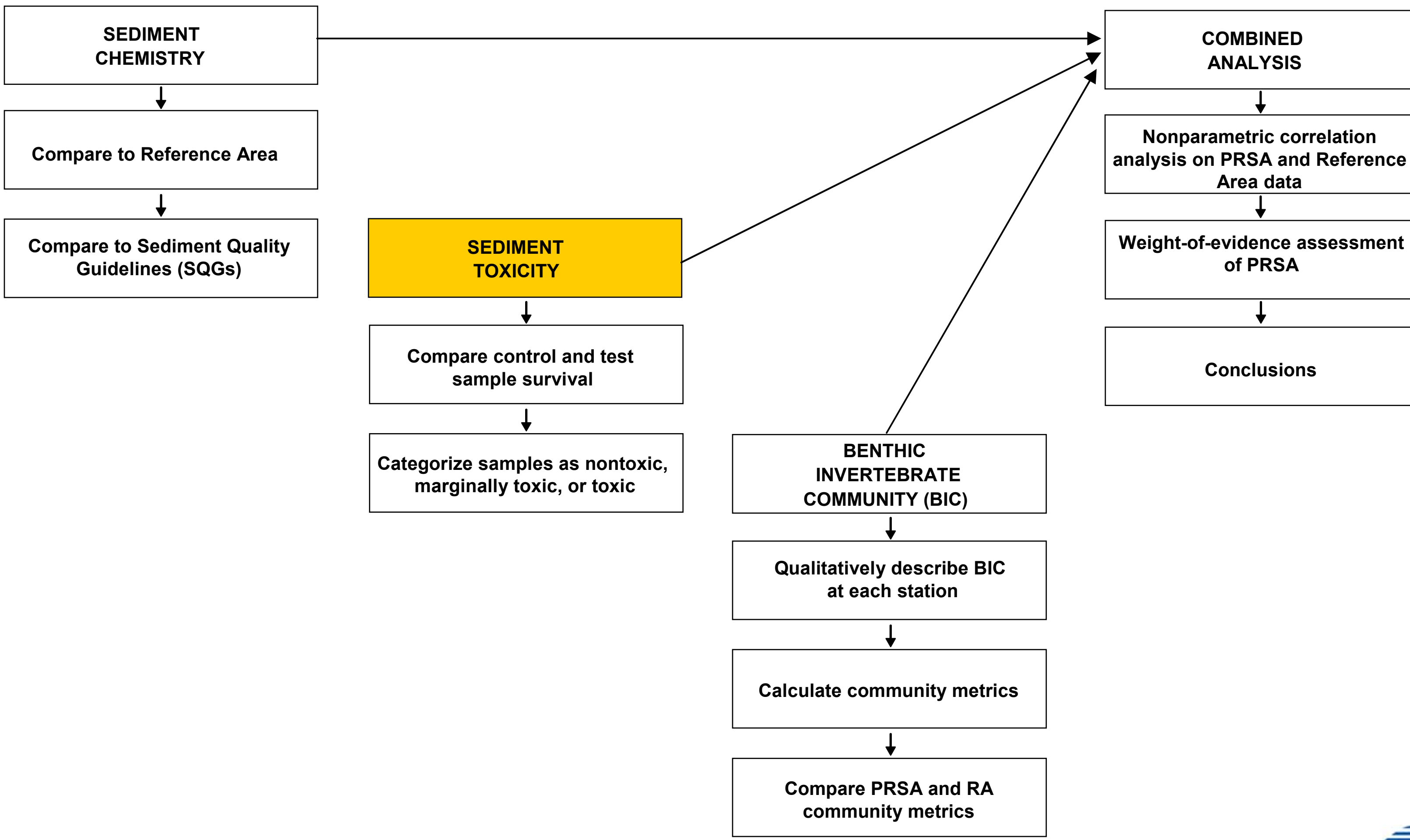
Steps in the SQT



PRSA Sediment Toxicity Data

- Described in detail in May 29, 2002 presentation
- Sediment for laboratory toxicity testing collected from central sampling grid at each ESP station

Sediment Sample Toxicity

A sample is considered:

Nontoxic	if	mean survival was not significantly different ($p > 0.05$) from negative controls
Marginally toxic	if	mean survival was significantly lower than in negative controls ($p < 0.05$) but exceeded 80% of average survival in controls (amphipods) or exceeded 64% of average survival in controls (polychaetes)
Highly toxic	if	mean survival was significantly lower than in negative controls ($p < 0.05$) and < 80% of average survival in controls (amphipods) or < 64% of average survival in controls (polychaetes)

Source: Long et al., 2000

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1999 PRSA Sediment Toxicity Testing Results

Station	Average Percent Survival (Amphipod)	Toxicity Category (Amphipod Survival)	Average Percent Survival (Polychaete)	Toxicity Category (Polychaete Survival)
PRSA				
1	70	Highly toxic	100	Nontoxic
2	68	Highly toxic	100	Nontoxic
3	83	Nontoxic	100	Nontoxic
4	85	Nontoxic	100	Nontoxic
5	79	Nontoxic	96	Nontoxic
6	72	Marginally toxic	100	Nontoxic
7	75	Marginally toxic	96	Nontoxic
8	43	Highly toxic	100	Nontoxic
9	46	Highly toxic	92	Nontoxic
10	75	Marginally toxic	100	Nontoxic
11	78	Nontoxic	92	Nontoxic
12	46	Highly toxic	84	Marginally Toxic
13	70	Highly toxic	92	Nontoxic
14	46	Highly toxic	100	Nontoxic
15	68	Highly toxic	96	Nontoxic
Reference Area				
21	95	Nontoxic	100	Nontoxic
22	92	Nontoxic	100	Nontoxic
23	92	Nontoxic	96	Nontoxic
Laboratory Controls				
1	89		100	
2	89		96	

Note:

Data was arcsine square root transformed, which made the data meet ANOVA assumptions then a one-tail t-test with equal variance was performed to see which stations were significantly different from the negative controls.

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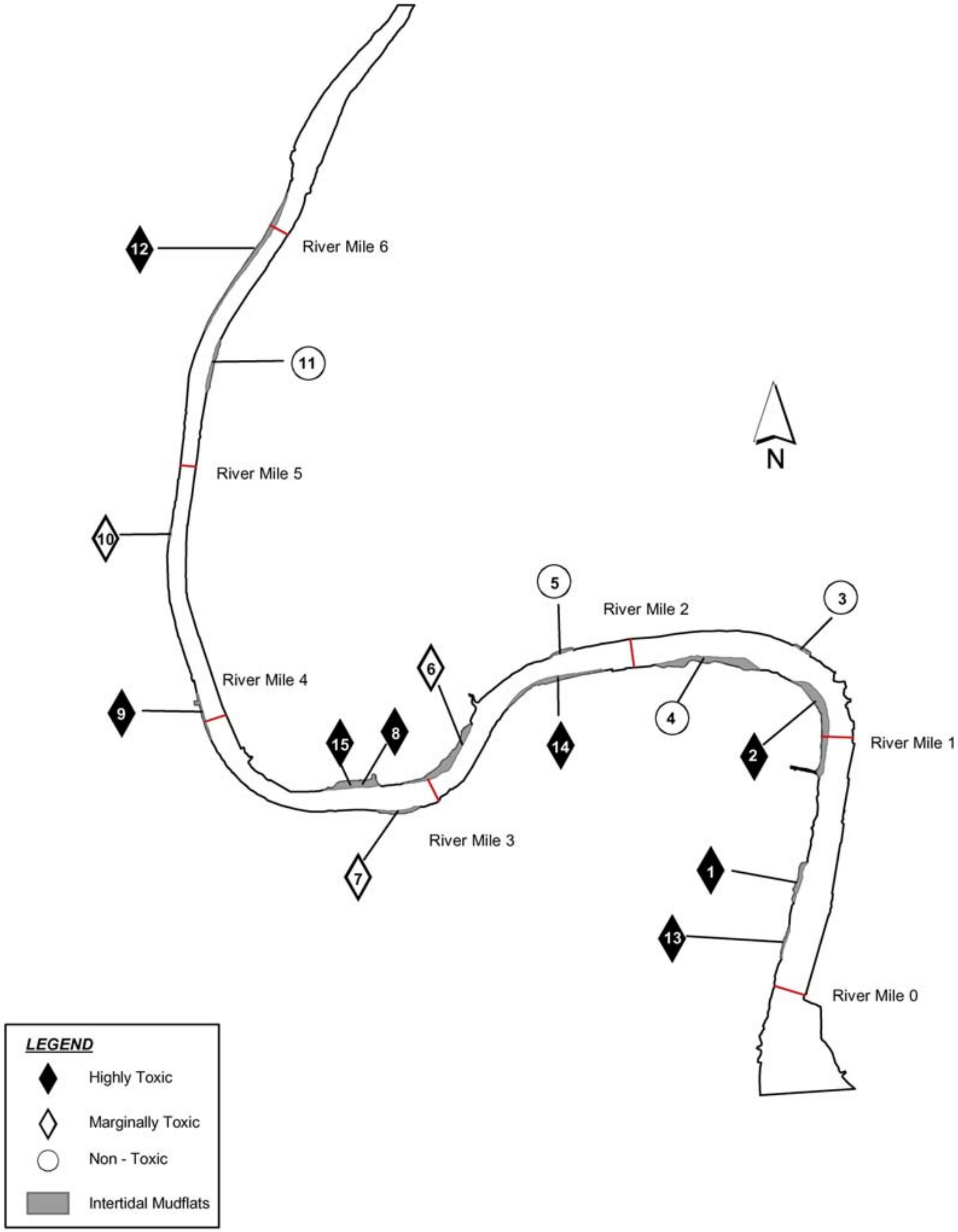
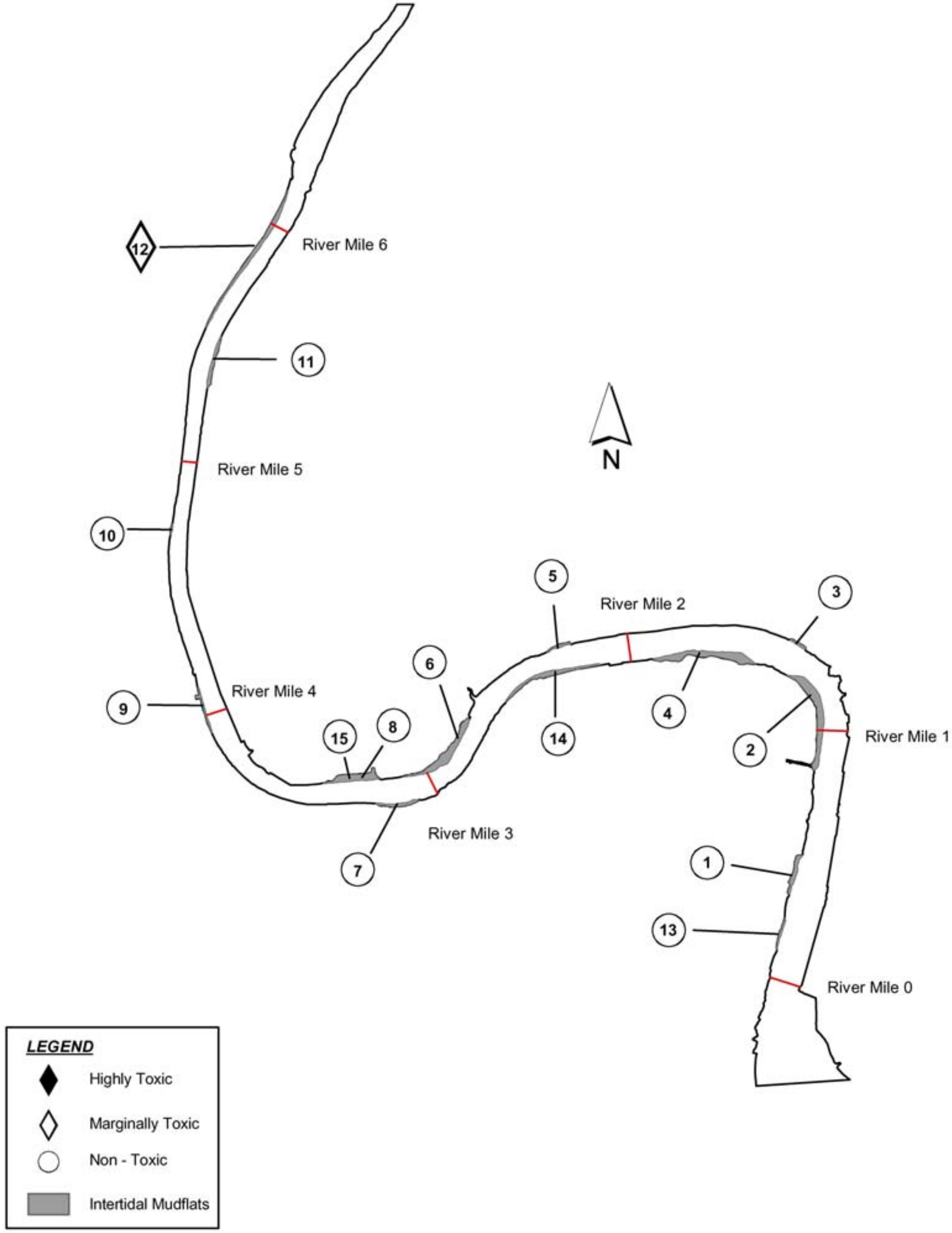
1999 PRSA Amphipod Sediment Toxicity Classifications



1999 PRSA Polychaete Sediment Toxicity Classifications



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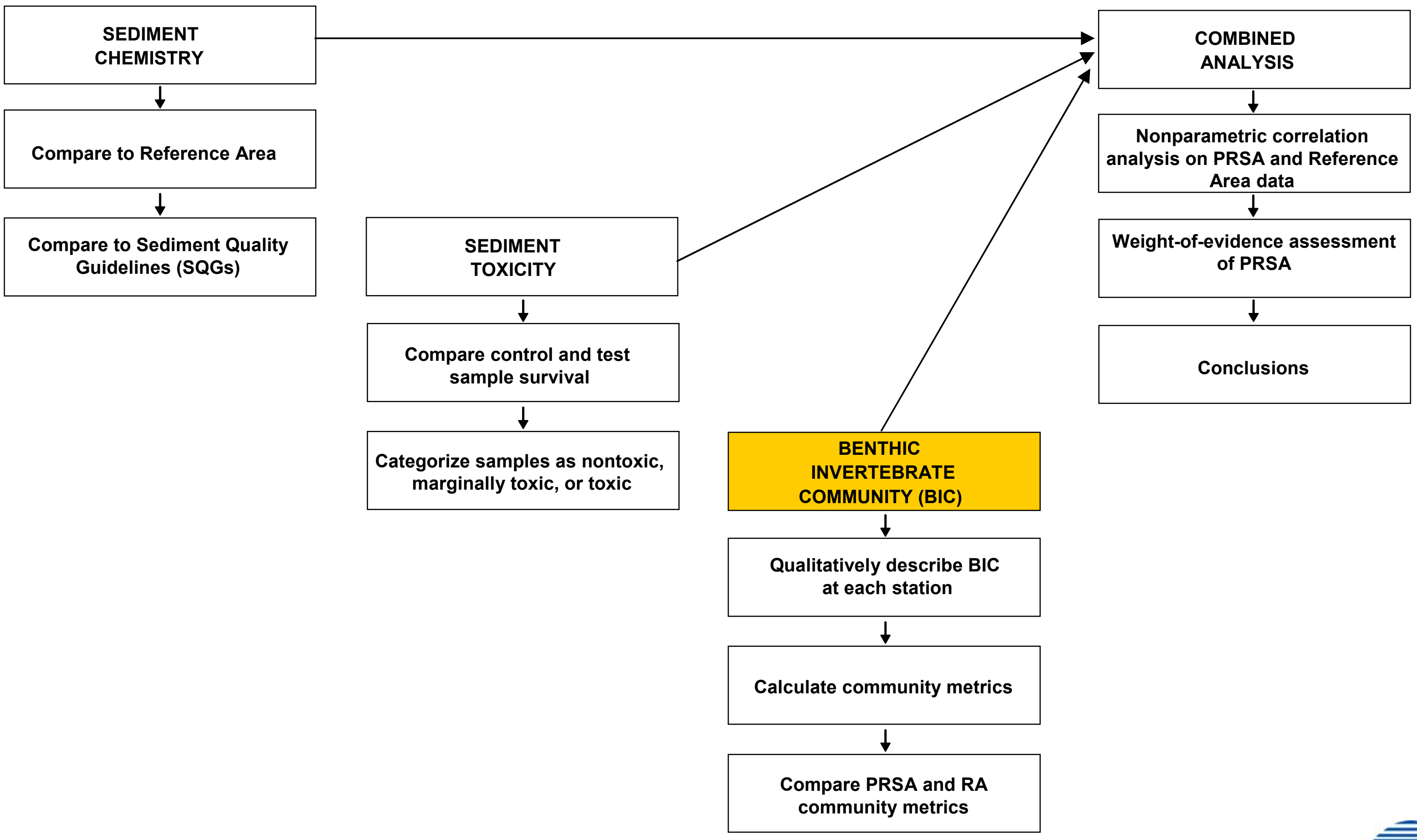
Steps in the SQT



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PRSA Benthic Invertebrate Community Data

- Described in detail in benthic invertebrate community presentation
- Sediment samples for benthic invertebrate community analysis collected from central sampling grid at each station
- Community structure and composition metrics used to classify PRSA stations relative to RA

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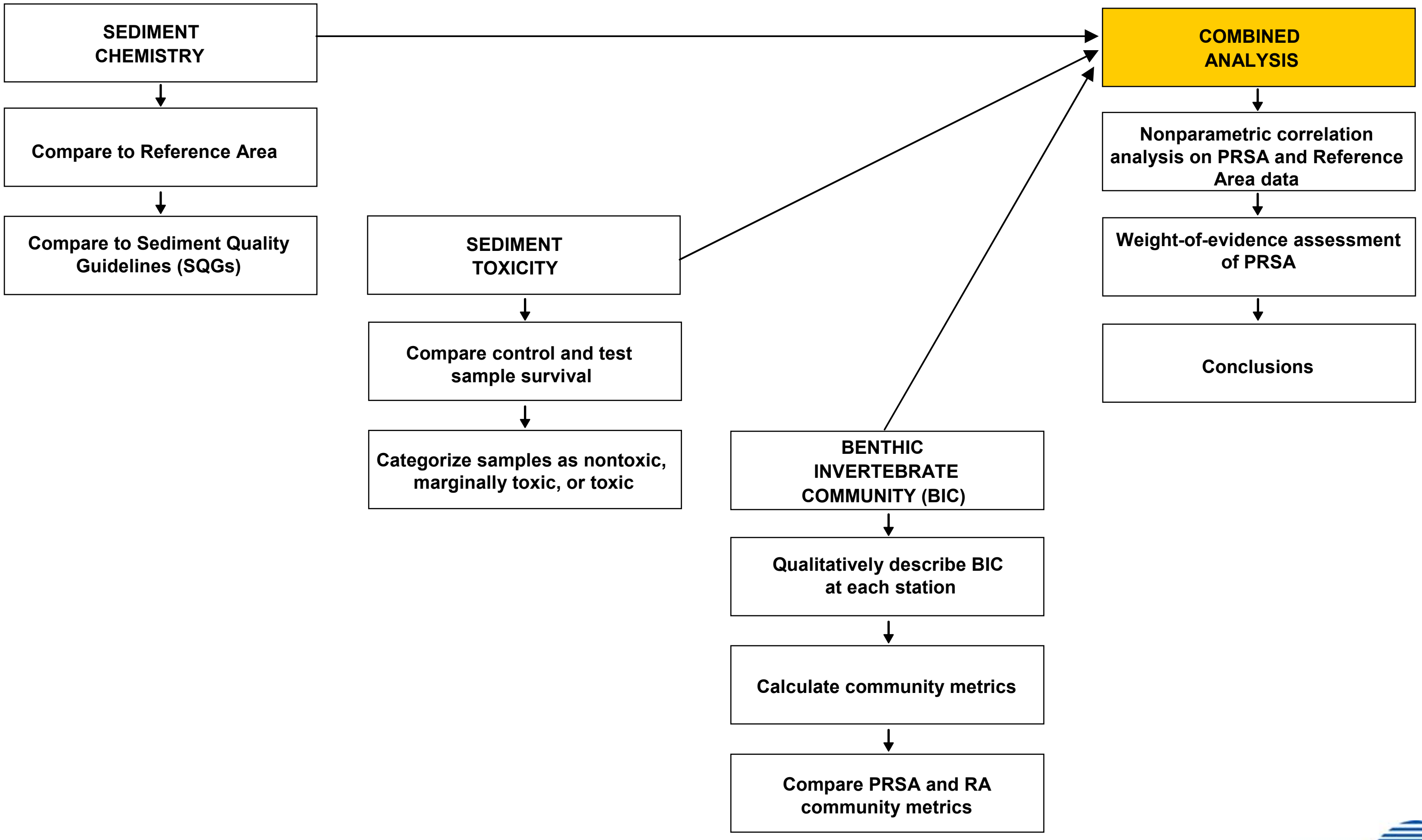
Qualitative Ranks for Each PRSA Station Compared to Reference Area

Metric	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of Individuals [1]	**poor**	good	good	good	good	good	good	good	good	good	**poor**	**poor**	good	good	**poor**
No. of Taxa	good	good	good	good	good	good	good	good	good	**poor**	good	**poor**	good	**poor**	good
Abundance of Crustacea	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**
Abundance of Tollerant Taxa [1]	**poor**	good	**poor**	good	good	good	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**	**poor**
Pielou's Eveness	**poor**	good	good	**poor**	good	good	good	good	good	**poor**	good	good	***excellent***	good	good
Shannon's H'	**poor**	**poor**	good	**poor**	**poor**	good	**poor**	good	**poor**	**poor**	**poor**	**poor**	***excellent***	**poor**	**poor**
Virginia IBI	**poor**	**poor**	good	**poor**	good	good	good	good	**poor**	**poor**	**poor**	**poor**	good	**poor**	**poor**
Brillouin's H	**poor**	**poor**	good	**poor**	**poor**	good	**poor**	good	**poor**	**poor**	**poor**	**poor**	***excellent***	**poor**	**poor**
Swartz Dominance Index	good	good	good	good	good	good	good	good	good	good	good	good	***excellent***	good	good

Note:

[1] For the number of individuals and abundance of tolerant taxa metrics, the following ranks were assigned to each PRSA and Reference Area comparison: 1) above reference range = poor; b) within reference range = good; c) below reference range = excellent. For the remaining metrics, the following ranks were assigned for each PRSA/Reference Area comparison: a) above reference area = excellent; b) within reference area = good; c) below reference area = poor

Steps in the SQT



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Nonparametric Spearman Rank Order Correlations

- Statistical analysis method used by NOAA National Status & Trends Program
- With a large number of variables, a Bonferroni correction must be applied to the alpha level ($\alpha = 0.05$) to reduce Type 1 error (chance of false positive result)
- Bonferroni correction = $\frac{\text{alpha level}}{\text{\# of variables}} = \frac{0.05}{47} = 0.001$
- A p-value ≤ 0.001 must be used for a correlation to be statistically significant

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Nonparametric Correlations Between Sediment Chemistry, Toxicity, and Benthic Invertebrate Community Metrics

Analyte	N	Amphipod Survival	Number of Organisms	Number of Taxa	Shannon-Wiener H'	Pielou's Eveness J	Brillouin Diversity (H)	Virginian Province Biotic Index	Swartz's Dominance Index	Percent Crustacea	Percent Pollution-Tollerant Organisms
Inorganic Chemicals											
Aluminum	18	0.347	-0.265	0.241	0.263	-0.018	0.262	0.447	0.170	0.603	-0.395
Antimony	18	0.138	-0.285	0.108	-0.229	-0.542	-0.243	0.355	-0.459	0.221	-0.396
Arsenic	18	0.538	-0.381	0.166	0.082	-0.044	0.076	0.393	0.125	0.607	-0.592
Barium	18	-0.465	0.040	-0.189	-0.257	-0.169	-0.267	-0.244	-0.078	-0.339	0.391
Beryllium	18	0.371	-0.439	0.347	0.291	0.058	0.288	0.568	0.174	0.781***	-0.612
Cadmium	18	-0.392	0.327	-0.522	-0.624	-0.346	-0.633	-0.532	-0.261	-0.640	0.376
Calcium	18	-0.133	-0.028	-0.242	-0.042	0.092	-0.047	-0.205	0.235	-0.251	0.334
Chromium	18	-0.370	-0.079	-0.334	-0.376	-0.206	-0.374	-0.225	-0.225	-0.279	0.204
Cobalt	18	-0.211	-0.195	-0.119	-0.181	-0.217	-0.191	-0.014	-0.125	0.005	-0.037
Copper	18	-0.321	-0.143	-0.216	-0.369	-0.317	-0.369	-0.153	-0.254	-0.310	0.203
Iron	18	0.503	-0.188	0.159	0.258	0.119	0.259	0.337	0.324	0.507	-0.325
Lead	18	-0.413	0.066	-0.247	-0.289	-0.193	-0.290	-0.329	-0.141	-0.505	0.448
Magnesium	18	0.510	-0.277	0.145	0.240	0.120	0.243	0.394	0.247	0.543	-0.402
Manganese	18	-0.569	0.284	-0.506*	-0.304	0.013	-0.315	-0.560	-0.011	-0.582	0.654
Mercury	18	-0.380	-0.032	-0.281	-0.344	-0.138	-0.331	-0.304	-0.257	-0.289	0.181
Nickel	14	0.031	-0.174	0.057	-0.064	-0.343	-0.053	0.073	-0.279	0.199	-0.109
Potassium	13	0.525	-0.242	0.116	0.201	0.105	0.198	0.517*	0.123	0.717	-0.648
Selenium	18	-0.284	0.147	-0.351	-0.366	-0.243	-0.356	-0.297	-0.368	-0.510	0.274
Silver	18	-0.407	0.007	-0.404	-0.508*	-0.322	-0.517	-0.324	-0.235	-0.406	0.338
Sodium	18	0.534	-0.399	0.265	0.216	0.036	0.223	0.535	0.079	0.706	-0.674
Thallium	14	-0.423	0.332	-0.678*	-0.640*	-0.306	-0.647	-0.590	-0.245	-0.746	0.303
Vanadium	18	0.449	-0.257	0.297	0.384	0.154	0.384	0.435	0.326	0.706	-0.474
Zinc	14	0.176	0.044	-0.191	-0.246	-0.378	-0.233	-0.233	-0.080	-0.246	0.246
SEM-AVS[a]	13	0.000	0.044	0.314	0.295	0.246	0.281	0.055	0.428	-0.222	0.442
Miscellaneous											
Ammonia Nitrogen	18	-0.039	0.478	-0.201	-0.134	0.047	-0.136	-0.266	0.048	-0.288	0.286
Percent Fines	18	0.048	-0.035	-0.102	-0.017	0.042	-0.036	0.094	0.047	0.215	-0.134
pH	18	0.152	-0.283	-0.107	-0.234	-0.422	-0.221	0.116	-0.354	0.144	-0.499
TOC	18	-0.156	-0.082	0.047	0.121	0.154	-0.115	-0.012	0.261	-0.147	0.259
Salinity	18	-0.041	-0.373	0.074	0.092	0.051	0.081	0.142	0.058	0.307	-0.291

Notes:

Using a Bonferroni-adjusted alpha level based on the number of analytes (47), p must be ≤ 0.001 for a significant correlation to exist.

[a] Stations with rejected Ni values were left out of the correlation analysis.

*** = p ≤ 0.001

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Nonparametric Correlations Between Sediment Chemistry, Toxicity, and Benthic Invertebrate Community Metrics (cont.)

Analyte	N	Amphipod Survival	Number of Organisms	Number of Taxa	Shannon-Wiener H'	Pielou's Eveness J	Brillouin Diversity (H)	Virginian Province Biotic Index	Swartz's Dominance Index	Percent Crustacea	Percent Pollution-Tollerant Organisms
Organotins											
Dibutyltin	17	-0.154	0.206	-0.417	-0.322	-0.084	-0.303	-0.517	-0.025	-0.639	0.547
Monobutyltin	17	-0.561	0.068	-0.193	-0.061	-0.043	-0.084	-0.114	-0.213	-0.155	0.161
Tributyltin	17	-0.325	0.142	-0.470	-0.339	0.113	-0.325	-0.509	0.021	-0.495	0.460
PCBs/Pesticides											
Total DDT	18	-0.679	0.121	-0.185	-0.239	0.040	-0.216	-0.367	-0.327	-0.417	0.482
Total PCBs (homologue)	18	-0.389	0.236	-0.544	-0.564	-0.255	-0.582	-0.558	-0.084	-0.656	0.558
PCDD/Fs											
PCDD/F TEQ (Fish)	18	-0.381	0.179	-0.452	-0.539	-0.162	-0.519	-0.491	-0.442	-0.596	0.265
PAHs											
H-PAHs	18	-0.485	0.325	-0.300	-0.257	-0.034	-0.257	-0.398	-0.163	-0.615	-0.560
L-PAHs	18	-0.569	0.251	-0.241	-0.109	0.129	-0.114	-0.360	-0.038	-0.552	0.449
Total PAHs	18	-0.501	0.311	-0.280	-0.224	-0.001	-0.224	-0.383	-0.135	-0.601	0.397
Semivolatile Compounds											
1,4-Dichlorobenzene	18	0.001	-0.126	0.006	0.096	0.069	0.115	0.105	-0.121	0.034	0.015
2,4-Dichlorophenol	18	-0.028	-0.126	-0.042	0.091	0.151	0.092	0.057	0.011	0.032	0.065
Bis(2-ethylhexyl)phthalate	18	-0.379	0.280	-0.420	-0.397	-0.114	-0.398	-0.495	-0.004	-0.531	0.517
Butylbenzylphthalate	18	-0.033	-0.201	0.183	0.334	0.237	0.346	0.212	0.097	0.154	-0.029
Carbazole	18	-0.024	-0.241	0.044	0.118	0.087	0.124	0.147	-0.114	0.132	-0.064
Dibenzofuran	18	-0.049	-0.293	0.172	0.312	0.258	0.314	0.244	0.103	0.160	0.099
Dibenzothiophene	18	-0.437	0.224	-0.220	-0.162	0.024	-0.170	-0.303	-0.038	-0.545	0.384
Di-n-butylphthalate	18	0.014	-0.233	0.062	0.135	0.050	0.132	0.189	0.014	0.125	-0.038
Di-n-octylphthalate	18	-0.238	-0.045	-0.105	-0.027	0.056	-0.018	-0.105	-0.113	-0.296	0.274
N-Nitrosodiphenylamine	18	-0.002	-0.230	0.080	0.221	0.210	0.233	0.180	0.037	0.151	-0.028

Notes:
Using a Bonferroni-adjusted alpha level based on the number of analytes (47), p must be ≤ 0.001 for a significant correlation to exist.
[a] Stations with rejected Ni values were left out of the correlation analysis.
*** = p ≤ 0.001

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Alternate (i.e., NOAA NS&T) Correlations Between Sediment Chemistry and Toxicity – Relaxed Assumptions of Statistical Significance

Analyte	N	Amphipod Survival
Inorganic Chemicals		
Aluminum	18	0.347
Antimony	18	0.138
Arsenic	18	0.538*
Barium	18	-0.465
Beryllium	18	0.371
Cadmium	18	-0.392
Calcium	18	-0.133
Chromium	18	-0.370
Cobalt	18	-0.211
Copper	18	-0.321
Iron	18	0.503*
Lead	18	-0.413
Magnesium	18	0.510*
Manganese	18	-0.569*
Mercury	18	-0.380
Nickel	14	0.031
Potassium	13	0.525
Selenium	18	-0.284
Silver	18	-0.407
Sodium	18	0.534*
Thallium	14	-0.423
Vanadium	18	0.449
Zinc	14	0.176
SEM-AVS[a]	13	0.000
Miscellaneous		
Ammonia Nitrogen	18	-0.039
Percent Fines	18	0.048
pH	18	0.152
TOC	18	-0.156
Salinity	18	-0.041

Analyte	N	Amphipod Survival
Organotins		
Dibutyltin	17	-0.154
Monobutyltin	17	-0.561*
Tributyltin	17	-0.325
PCBs/Pesticides		
Total DDT	18	-0.679**
Total PCBs (homologue)	18	-0.389
PCDD/Fs		
PCDD/F TEQ (Fish)	18	-0.381
PAHs		
H-PAHs sum 24		-0.541
L-PAHs sum 24		-0.569
Total PAHs sum 24		-0.549
H-PAHs	18	-0.485*
L-PAHs	18	-0.569*
Total PAHs	18	-0.501*
Semivolatile Compounds		
1,4-Dichlorobenzene	18	0.001
2,4-Dichlorophenol	18	-0.028
Bis(2-ethylhexyl)phthalate	18	-0.379
Butylbenzylphthalate	18	-0.033
Carbazole	18	-0.024
Dibenzofuran	18	-0.049
Dibenzothiophene	18	-0.437
Di-n-butylphthalate	18	0.014
Di-n-octylphthalate	18	-0.238
N-Nitrosodiphenylamine	18	-0.002

Notes:

Using a Bonferroni-adjusted alpha level based on the number of analytes (47), p must be ≤ 0.001 for a significant correlation to exist.

[a] Stations with rejected Ni values were left out of the correlation analysis.

* = p ≤ 0.05
** = p ≤ 0.01

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Spearman Rank Correlations of Sediment Quality Guidelines and Toxicity and Benthic Invertebrate Community Parameters (n=18)

	Amphipod Survival	Number of Individuals	Number of Taxa	Shannon-Wiener Diversity Index	Pielou's Eveness (J)	Brillouin's H	Swartz Dominance Index	Virginian Province IBI	Percent Crustacea	Percent Pollution-Tolerant Organisms
ER-MQ (PAH categories)	-0.553	0.235	-0.374	-0.322	0.082	-0.316	-0.047	-0.618**	-0.719**	0.677**
ER-MQ (PAH individual)	-0.491	0.239	-0.311	-0.269	0.088	-0.263	-0.061	-0.533	-0.702**	0.553
SQGQ ER-M + Mn	-0.565	0.275	-0.406	-0.361	0.060	-0.355	-0.080	-0.649**	-0.756**	0.694**
SQGQ ER-M + BEP	-0.523	0.282	-0.372	-0.341	0.011	-0.334	-0.061	-0.632**	-0.697**	0.635**
SQGQ ER-M + PCDD/F TEQ	-0.544	0.261	-0.384	-0.350	0.024	-0.345	-0.065	-0.645**	-0.726**	0.663**
SQGQ All benchmarks	-0.497	0.236	-0.368	-0.328	0.031	-0.321	-0.037	-0.614**	-0.696**	0.622**

Notes:
Using a Bonferroni adjusted alpha level based on the number of analytes (6), p must be ≤ 0.01 for a significant correlation to exist.
** = p ≤ 0.01

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Concordance of Triad Components

Station	Sediment Type	Sediment Toxicity	BIC Condition	Component Agreement
13	*3*	Highly toxic	Good - Excellent	No
1	*3*	Highly toxic	Poor	Yes
2	*3*	Highly toxic	Poor - Good	Yes
3	*2*	Nontoxic	Good	Yes
4	*3*	Nontoxic	Poor - Good	No
14	*3*	Highly toxic	Poor	Yes
5	*3*	Nontoxic	Good	No
6	*3*	Marginally toxic	Good	No
7	*3*	Marginally toxic	Poor - Good	No
8	*3*	Highly toxic	Good	No
15	*3*	Highly toxic	Poor	Yes
9	*4*	Highly toxic	Poor - Good	Yes
10	*3*	Marginally toxic	Poor	Yes
11	*4*	Nontoxic	Poor	No
12	*3*	Highly toxic	Poor	Yes

Note:
Stations ordered from downstream to upstream in PRSA.

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SQT Uncertainties

- Unidentified/unanalyzed chemicals could be impacting sediment toxicity and benthic invertebrate community structure
- Seasonal effects on sediment toxicity, sediment chemistry, and benthic invertebrate community structure and composition
- Role of chemical synergy in sediment toxicity and benthic invertebrate community structuring
- No SQGs available for many detected chemicals

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Overall Weight-of-Evidence Conclusions

- Elevated levels of chemicals found at many PRSA stations relative to Reference Area
- No clear spatial gradients in chemical concentrations present in the PRSA
- Sediment quality guidelines exceeded for a number of chemicals at multiple stations
- Amphipod toxicity detected in PRSA samples – no clear spatial gradient
- Amphipod toxicity not likely caused by single chemical or physical factor
- PRSA benthic invertebrate community structure and composition generally “poor” relative to the Reference Area

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Next Steps

- Multi-variate statistical analyses
- Evaluate SQT with respect to TIE results

Phase I Toxicity Identification Evaluation (TIE)

Preliminary Assessment

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Objectives

- Determine if one or more chemical classes appear responsible for sediment toxicity to benthic invertebrates in the PRSA
- Perform an investigation to supplement the sediment quality triad (SQT) assessment being performed under the CERLCA RI/FS

Field Sampling Methods

- July 2000 sampling event
- Five stations in the PRSA – corresponding to ESP stations 7, 11, 12, 13, and 14
- Stations selected for apparent differences in predominant chemical contaminant mixtures
- Surface sediment samples collected

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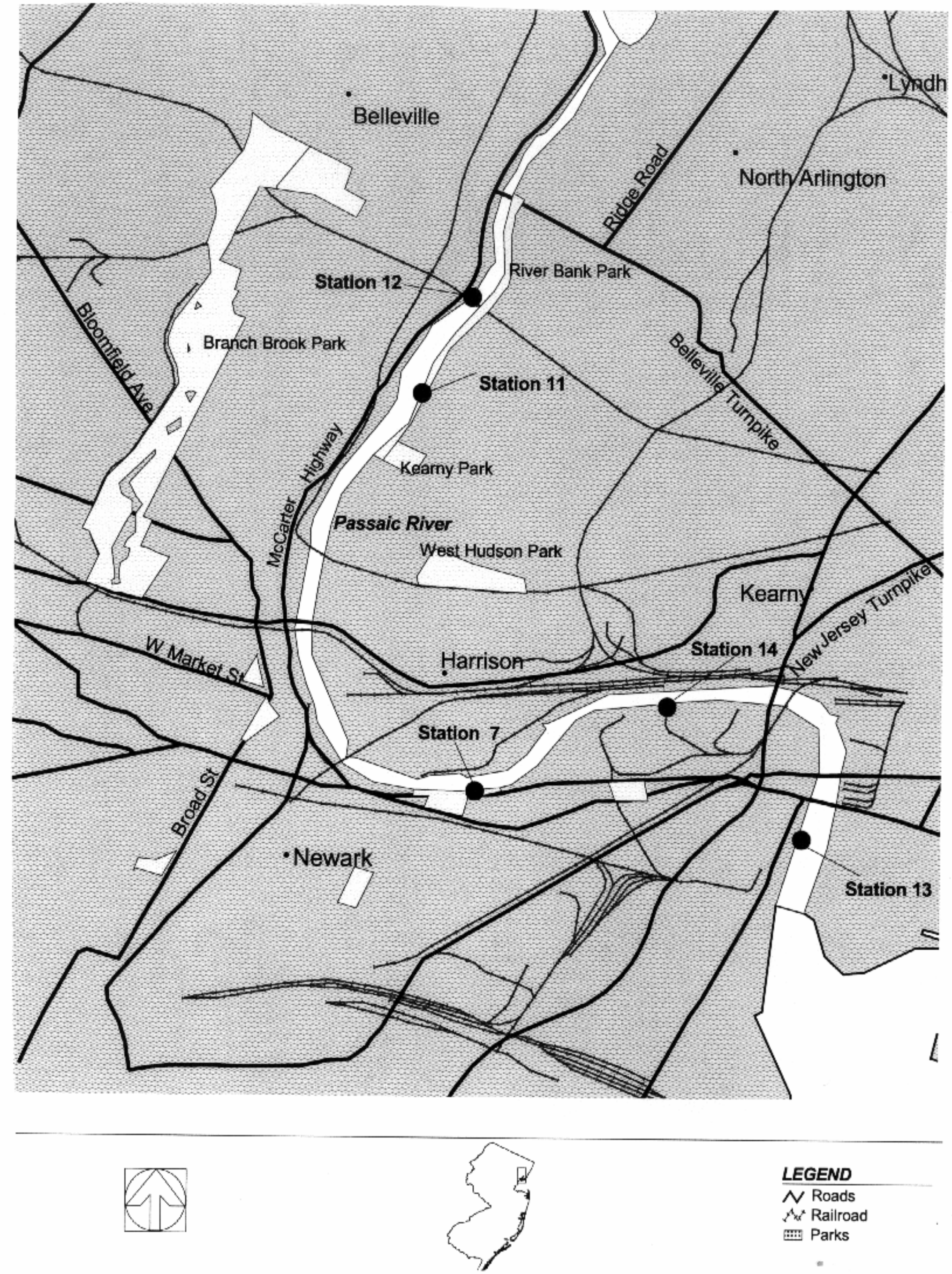
Locations of TIE Sample Stations



Customized Stainless Steel Mixer Used to Homogenize PRSA Sediment Samples

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Laboratory Methods

- Followed USEPA (1996) Phase I Marine TIE procedures – pore water manipulations
- Contaminant chemistry analyses (comparable to CERCLA RI/FS) performed on sediment and pore water samples
- Sediment and pore water toxicity tests using the amphipod *Ampelisca abdita*
- Additional Microtox® pore water toxicity tests

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TIE Methods Summary

- Initial and baseline toxicity tests
- Multiple pore water manipulations – results compared to baseline
- Five pore water dilutions for each manipulation (0, 25%, 50%, 75%, 100%)
- Dose-response relationships examined – LC50s calculated

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Summary of Phase I TIE Manipulations Performed on Pore Water Samples from Each Station

Manipulation Type	Chemical Focus of Manipulation
Filtration	To remove toxicity associated with particulate-bound toxicants
Aeration	To remove toxicity associated with volatile organic compounds, sulfides, and ammonia
Ethylenediaminetetraacetic acid (EDTA) chelation	To remove toxicity associated with metals
Sodium thiosulfate ($Na_2S_2O_3$) treatment	To remove toxicity associated with oxidants (i.e., chlorine), and some metals
Solid-phase extraction (SPE) through a C-18 column/follow-up elution	To remove toxicity associated with non-polar organic compounds such as pesticides, PCDD/Fs, and PAHs
Graduated pH adjustment to pH 7, pH *i*, and pH 9	To remove pH-dependent toxicants such as ammonia and hydrogen sulfide
SPE through a cation exchange resin/follow-up elution	To remove toxicity associated with divalent metals
Ulva lactuca treatment	To remove toxicity associated primarily with ammonia, with some secondary removal of hydrogen sulfide and organic compounds

Results

- Percent amphipod survival in sediments was zero or near zero in each sample
- Pore water toxicity to amphipods varied between stations in initial and baseline tests
- No toxicity observed during baseline toxicity test (pore water) at Station 11
- Some post-manipulation toxicity tests had either high control mortality or no dose-response relationship

Comparison of Initial and Baseline Study Results Using *Ampelisca abdita*

Station	Whole Sediment 10 days (% survival)	Pore Water (48 hours LC50)	
		Initial	Baseline[a]
7	0	24	29
11	0	83	>100
12	0	73	<13
13	3	14	33
14	0	35	75

Notes:

[a] Baseline tests conducted in conjunction with TIE manipulation samples (48 hours after initial tests).

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Results

- No toxicity in Microtox® tests in pore water samples from Stations 11, 13, and 14 – low toxicity at stations 7 and 12
- Suggests that the following are not likely toxicants:
  - Oxidants
  - Dissolved phase metals
  - Dissolved phase neutral organics

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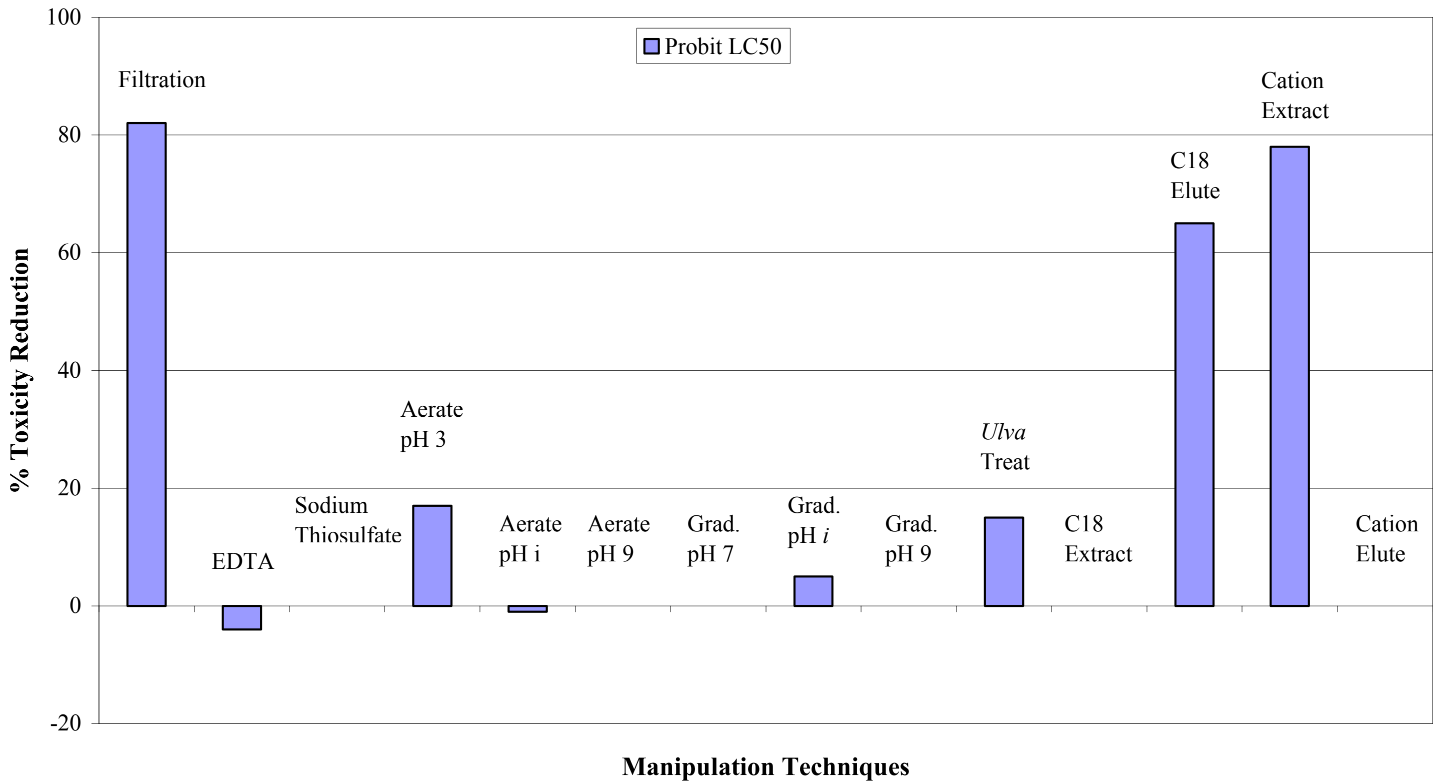
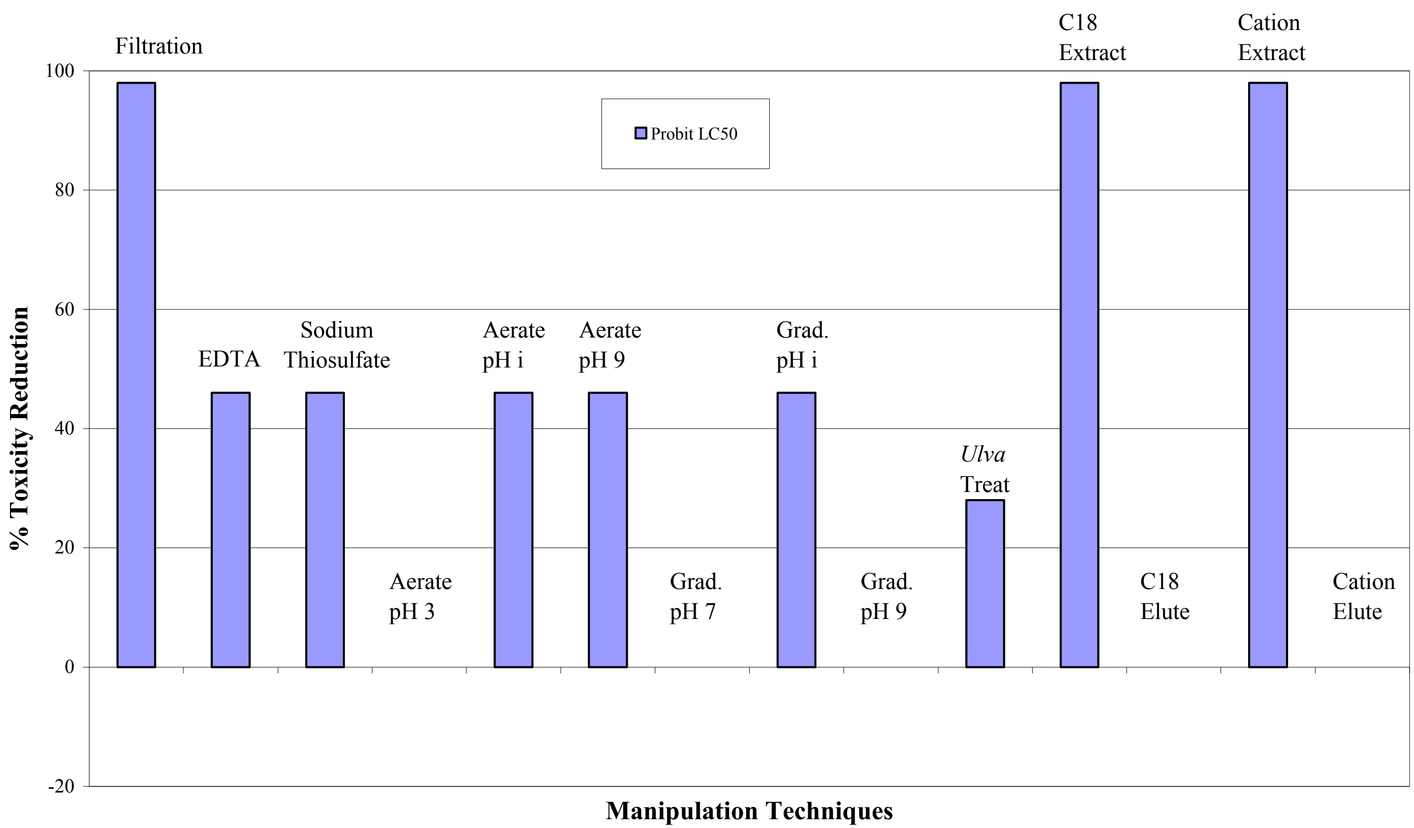
Comparison of 48-Hour Toxicity Study Results for Phase I TIE Manipulations for Station 7 Based on LC50 Analysis



Manipulated fraction results compared to baseline results.

Comparison of 48-Hour Toxicity Study Results for Phase I TIE Manipulations for Station 12 Based on LC50 Analysis



Manipulated fraction results compared to baseline results.

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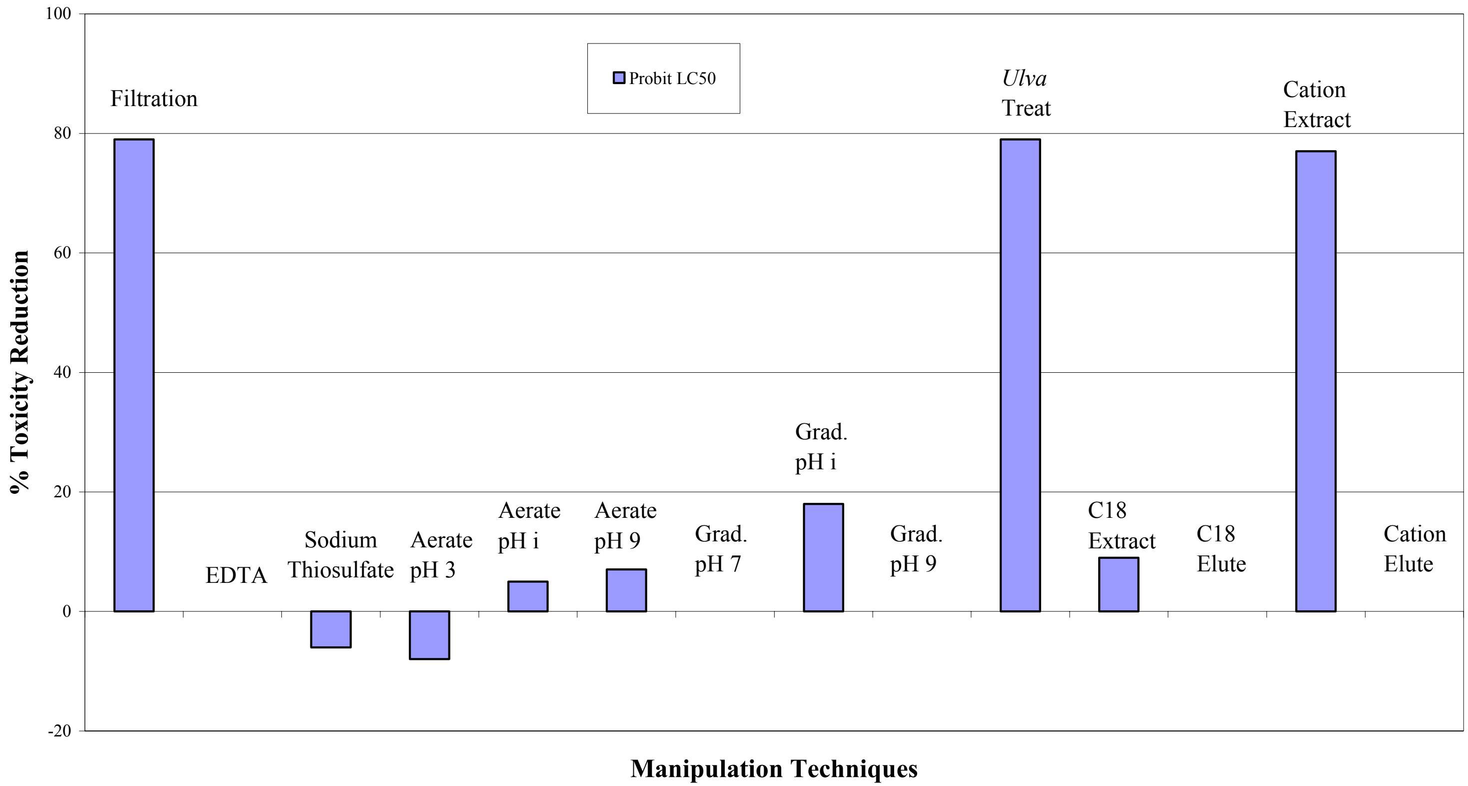
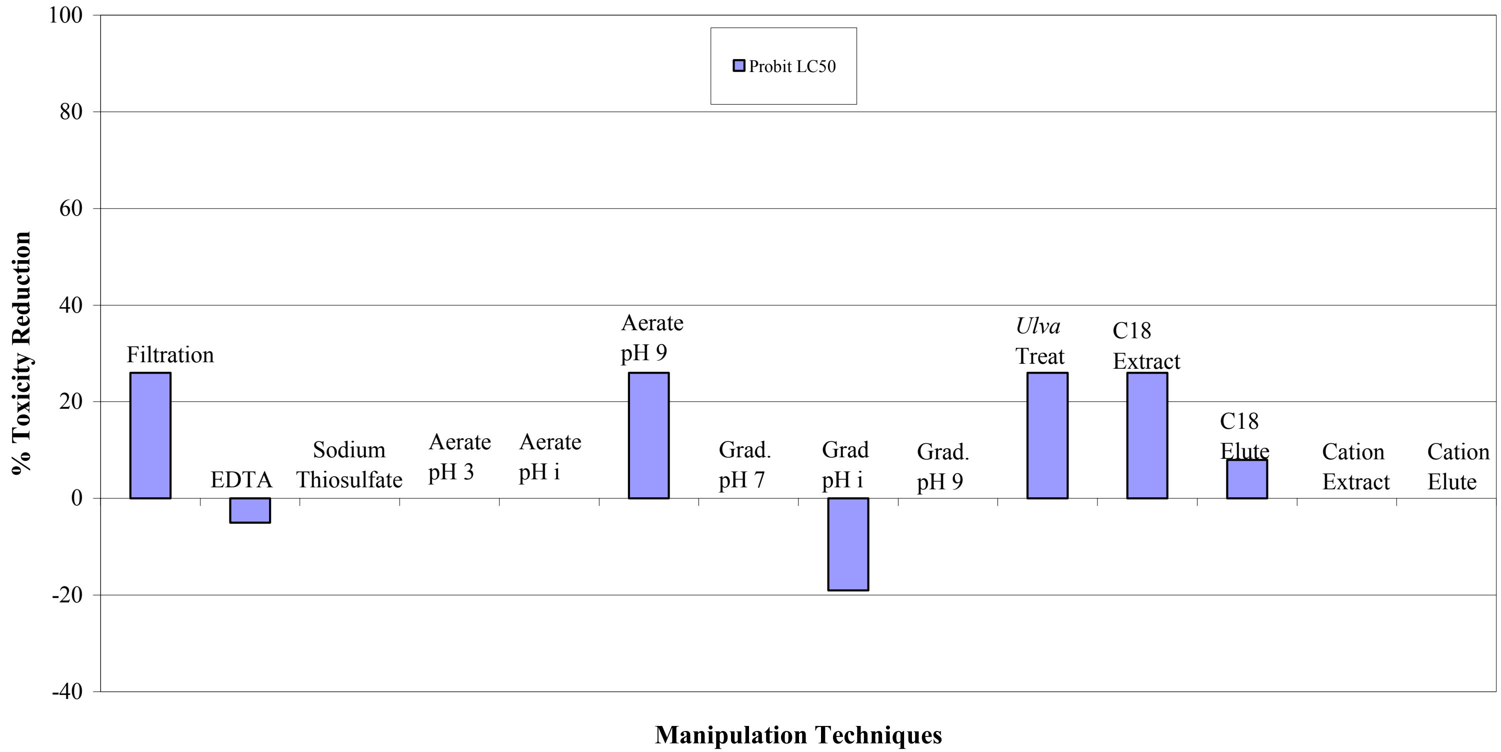
Comparison of 48-Hour Toxicity Study Results for Phase I TIE Manipulations for Station 13 Based on LC50 Analysis



Manipulated fraction results compared to baseline results.

Comparison of 48-Hour Toxicity Study Results for Phase I TIE Manipulations for Station 14 Based on LC50 Analysis



Manipulated fraction results compared to baseline results.

TIE Results – Preliminary Interpretation

Manipulation	Key Chemical Class	Results Station 7	Results Station 12	Results Station 13	Results Station 14
Filtration	Particles	++	++	++	+
Aeration	VOCs/Ammonia/Sulfides	-	+	+	+
EDTA Chelation	Metals	-	+	NR	-
$Na_2S_2O_3$ Treatment	Metals	NR	+	-	NR
pH Adjustments	Ammonia/Sulfides	-	+	+/-	-
C-18 SPE	Nonpolar Organic Compounds	NR	++	+	+
Cation Exchange SPE	Metals	++	++	++	NR
Ulva lactaca Treatment	Ammonia/Sulfides	+	+	++	+
TIE Interpretation Regarding Possible Causes of Toxicity:	1.	Particle-associated toxicity	Particle-associated nonpolar organic compounds	Particle-associated nonpolar organic compounds	Particle-associated nonpolar organic compounds
	2.		Particle-associated metals	Particle-associated metals	Ammonia
	3.		Ammonia	Ammonia	Low response = other contributors

Notes:
++ = indicates strong toxicity reduction.
+ = indicates low to moderate toxicity reduction.
- = indicates ineffective toxicity reduction.
NR = no dose-response relationship or high control mortality occurred in this manipulation.

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Preliminary Conclusions

- Toxicity characteristics at stations exhibiting baseline toxicity were consistent with particle-associated chemicals
  - Toxicity removed primarily by filtration
  - Sediment tests had higher toxicity than pore water tests
  - Microtox® toxicity low or zero
- Ammonia may be a seasonal contributor to toxicity

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Next Steps

- Evaluate TIE results with respect to sediment and pore water chemistry analyses (e.g., toxic units assessment)
- Final interpretation
- Integration with SQT

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Wrap-Up Discussion

Action Items and Assignments

Data Gaps for PRRI

- Water chemistry data
- CSO data
- Tissue chemistry data (PRSA to Dundee Dam)
- Sediment chemistry data (PRSA to Dundee Dam)
- Sediment toxicity data (PRSA to Dundee Dam)
- Quantitative habitat/bird relationship for restoration
- Habitat characterization (PRSA to Dundee Dam)
- Geotechnical/hydrodynamic field data (PRSA to Dundee Dam)
- Other

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Next Meeting

- Potential meeting date: Friday, November 8, Silver Spring, MD
- Dioxin sources identification analyses
- Technical Work Group(s) establishment
- Trustee presentation/discussion
- Other?